



EXPLORE DESIGN PERFECTION



modeFRONTIER

The Integration Platform for Multiobjective
and Multidisciplinary Optimization

Danilo Di Stefano

Product manager modeFRONTIER



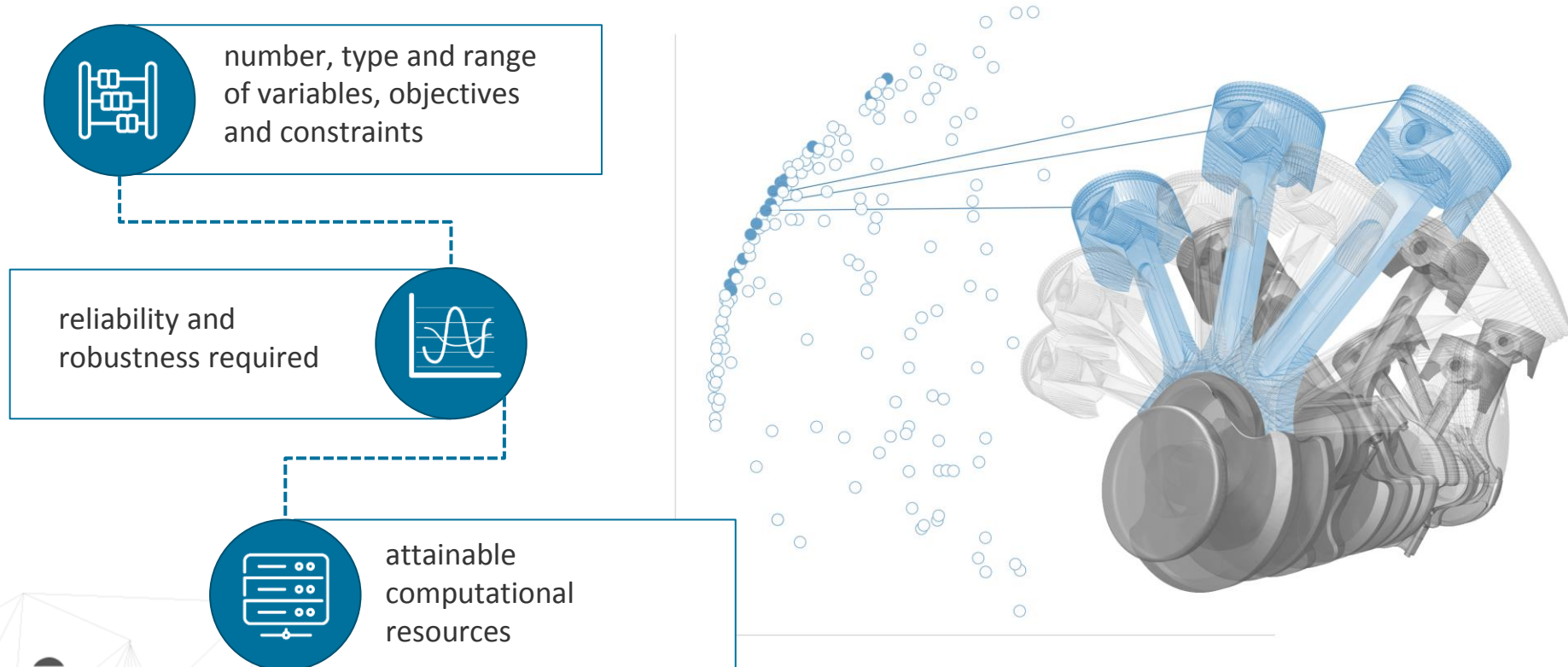
Your True Partner for
CAE × CFD
ICSC2016

IDAJ CAE
Solution
Conference

>> Multiobjective Optimization with modeFRONTIER

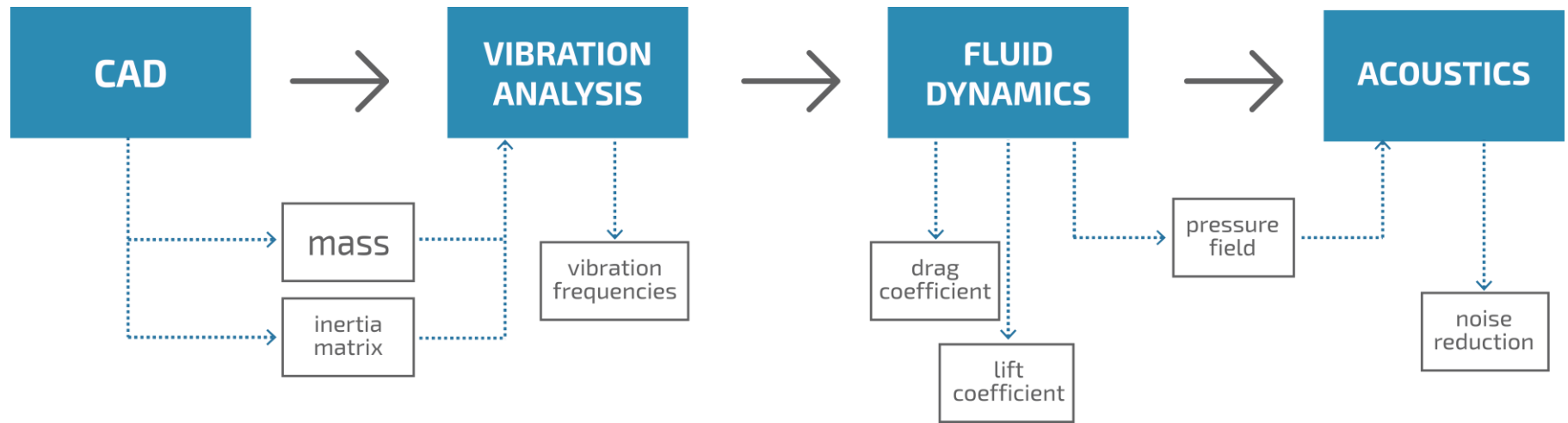
Multi-objective problems are solved using **sophisticated optimization algorithms**, which identify a set of **Pareto designs** whose objective functions are non-dominated by any other design among those tested.

With **modeFRONTIER** you can define **the most suitable optimization strategy** according to:



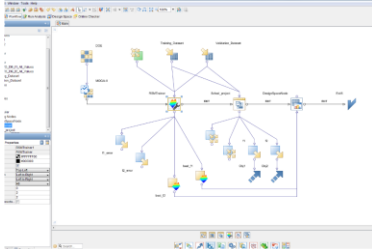
>> Multidisciplinary Optimization with modeFRONTIER

modeFRONTIER integrates with **any parametric software** (CAD, CAE, FEM, generic, etc.) **automating** the entire optimization process in which data is transferred from one simulation to the next and the relevant values of outputs and objectives are extracted.



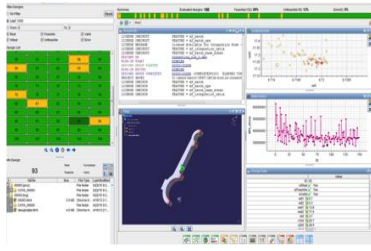
This **multidisciplinary approach** allows to exploit the **interaction** between the disciplines and determine the **global optimum solution**, instead of optimizing each discipline sequentially.

modeFRONTIER offers a **modular environment** giving access to different sets of functionalities



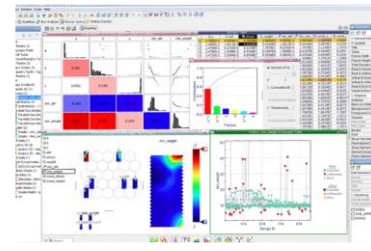
ACCESS THROUGH **mFmP**
modeFRONTIER modePROCESS

WORKFLOW BUILDING



ACCESS THROUGH **mF**
modeFRONTIER

PROCESS MONITORING



ACCESS THROUGH **mFmS**
modeFRONTIER modeSPACE

ANALYZING RESULTS



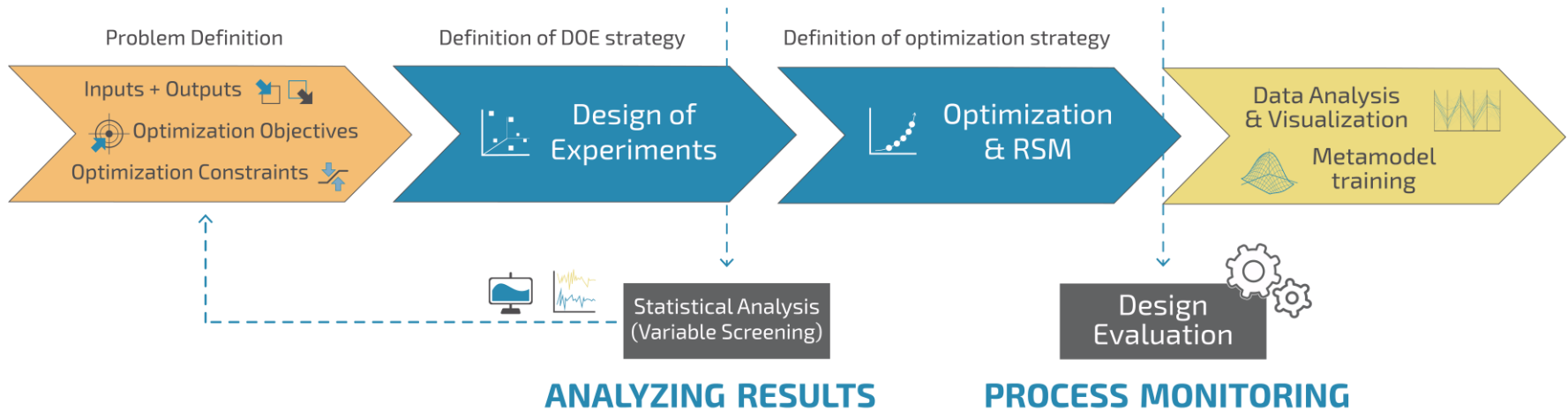
Each of these groups of capabilities is tailored to achieve the ultimate goal
» **DESIGN OPTIMIZATION**

>> modeFRONTIER Process Flow



WORKFLOW BUILDING

ANALYZING RESULTS





EXPLORE DESIGN PERFECTION



mf₂₀₁₆ **modeFRONTIER**

Concept

esteco.com



**Consolidate
specialized
expertise *and*
streamline
teamwork**

Improving efficiency

- ✓ Tailored access to functions
- ✓ Flexible team-focused licensing

Reducing complexity

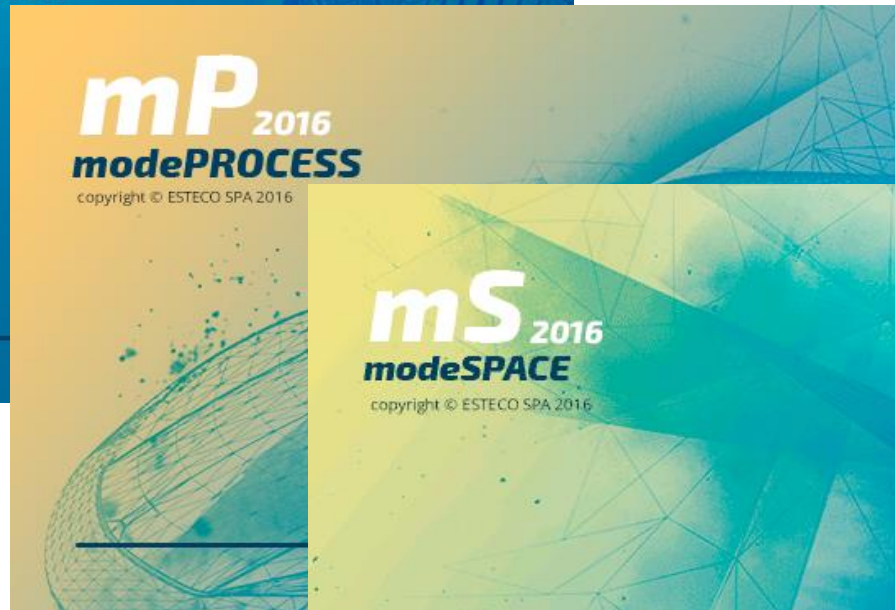
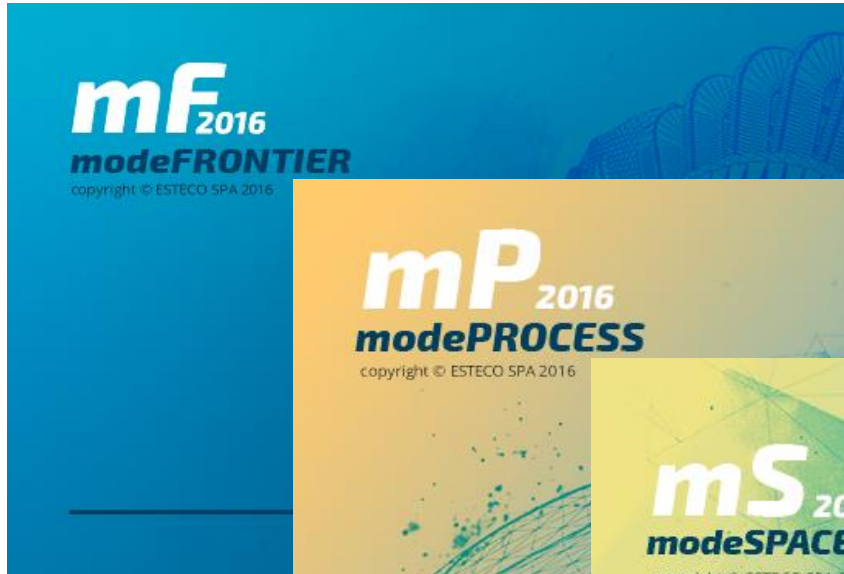
- ✓ Workflow management
- ✓ Customized views

Cutting development time

- ✓ Programmatic access to Design Space functions
- ✓ Enhanced wizards for key functions



modeFRONTIER2016 Modular Environment





EXPLORE DESIGN PERFECTION

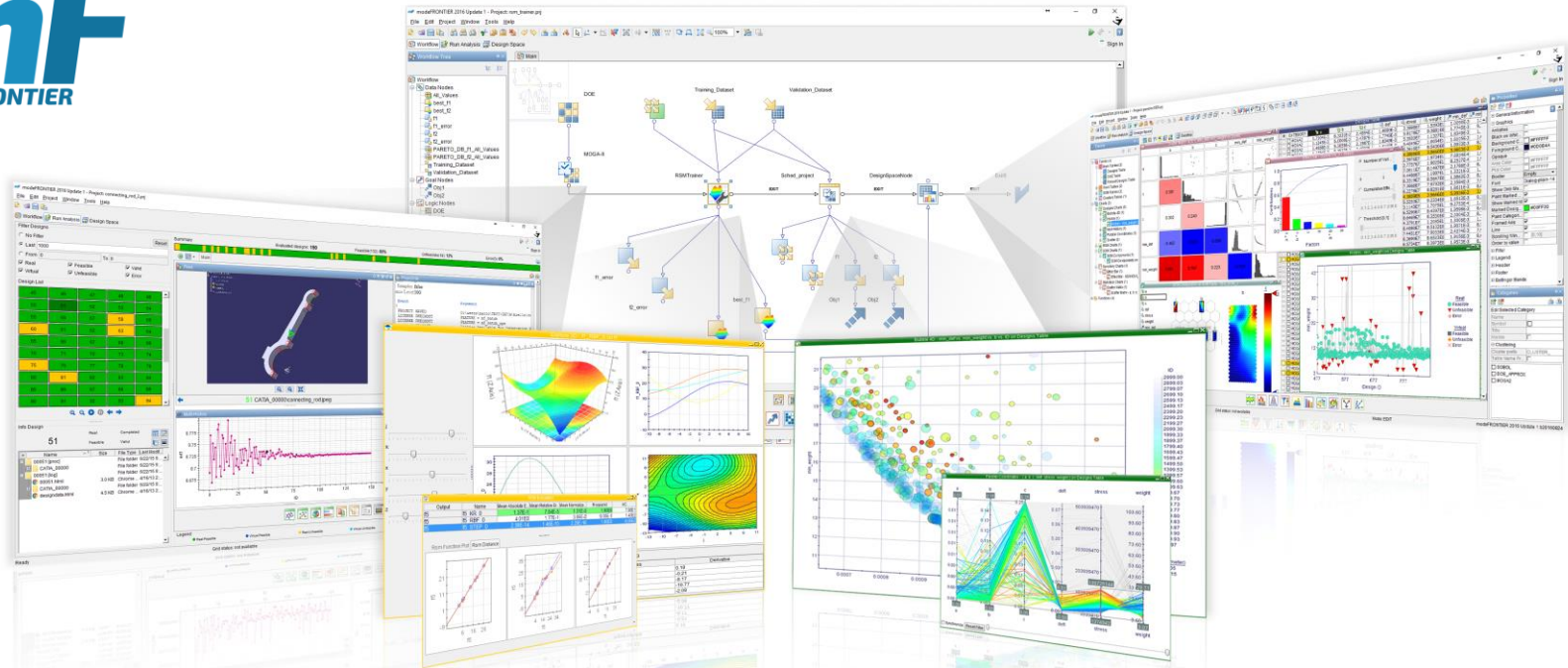


mf₂₀₁₆ **modeFRONTIER**

Modules

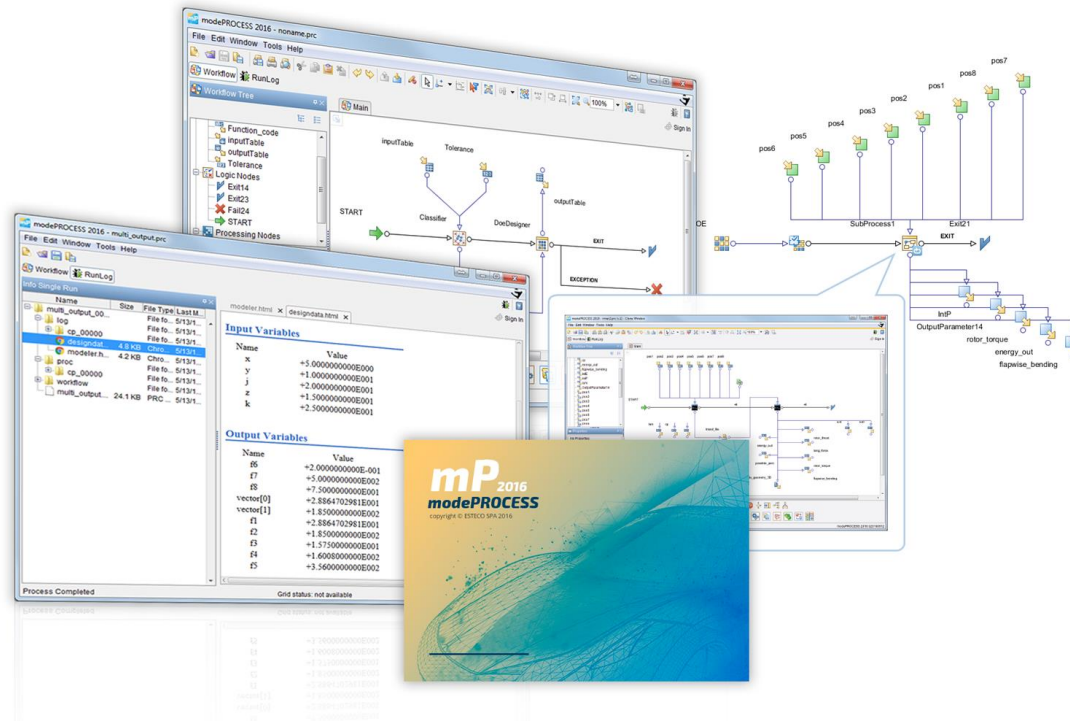
esteco.com





modeFRONTIER

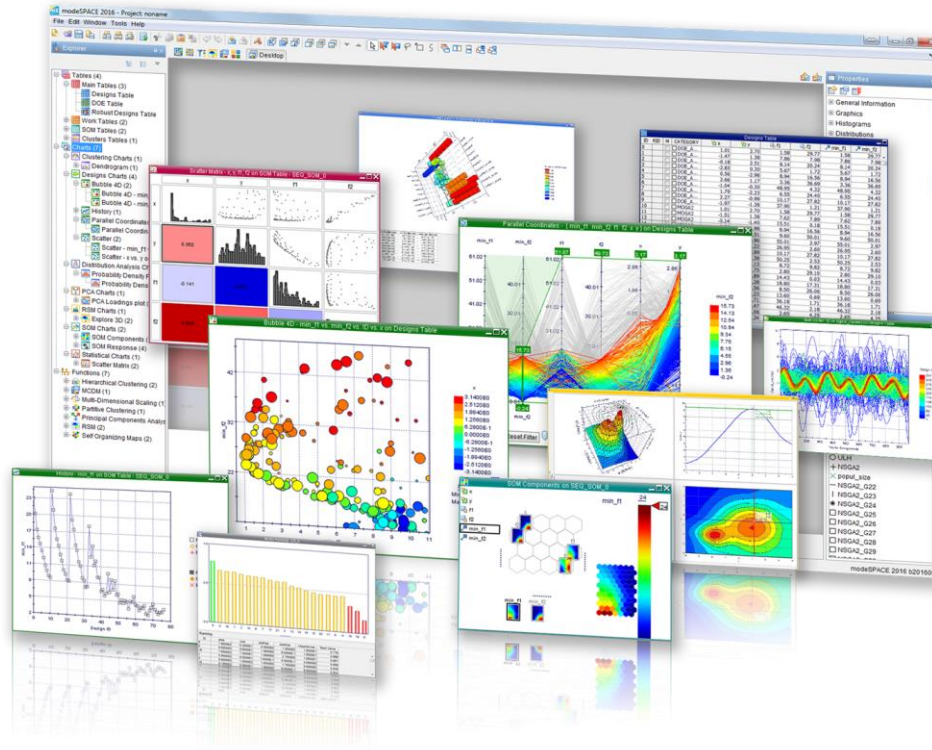
Streamlines the design process with powerful workflows, innovative algorithms and sophisticated post-processing tools. Its advanced capabilities for multidisciplinary design, keeps it at forefront of engineering technology.



modePROCESS

Independent desktop application useful to describe processes in the form of graphical workflows, by specifying which parameters and calculations are required to solve a design problem.

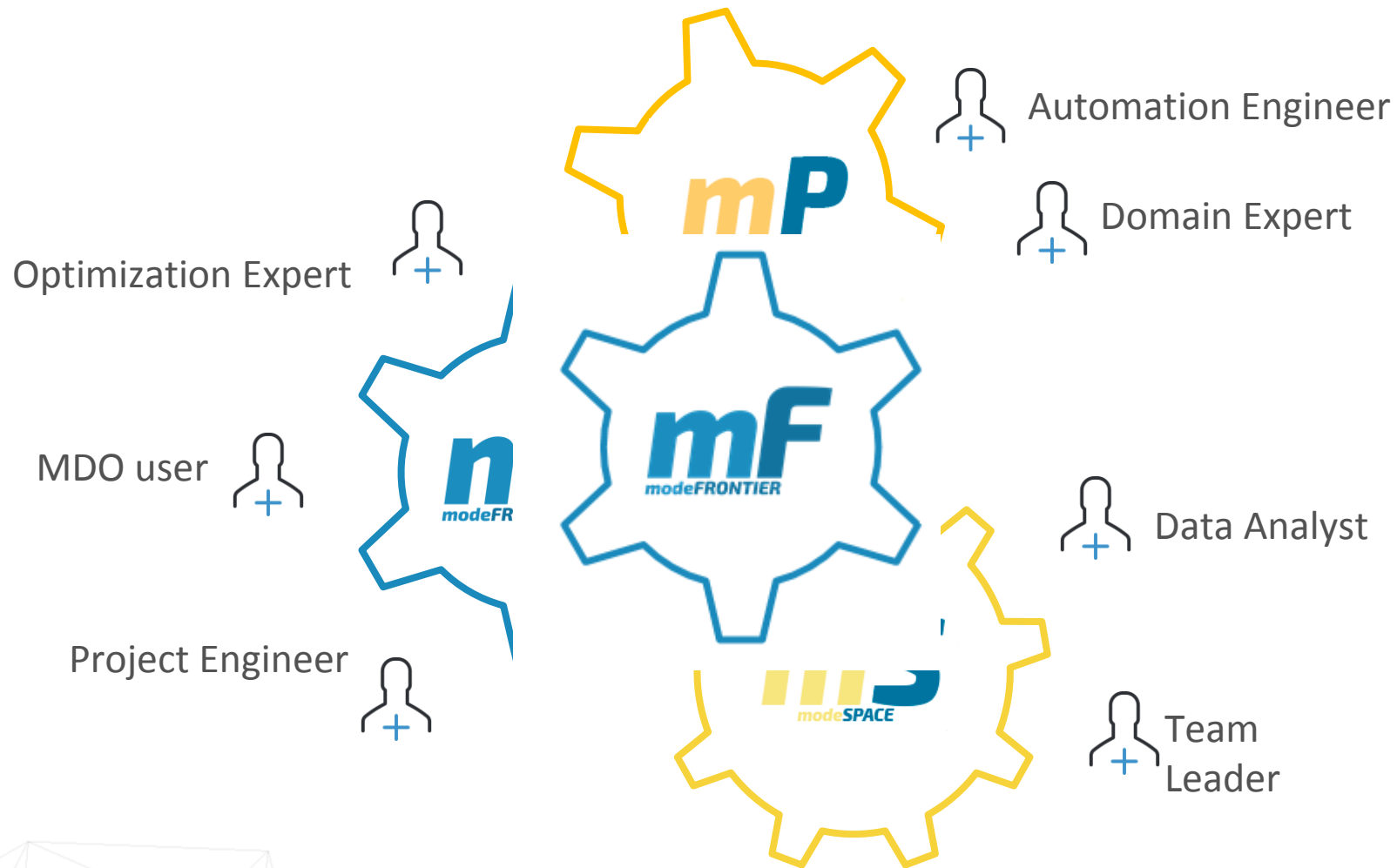




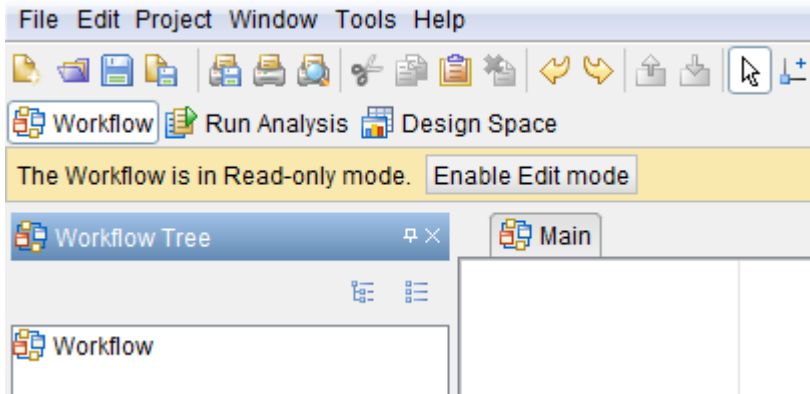
modeSPACE

Includes the sophisticated set of modeFRONTIER tools for data analysis and problem investigation and support to decision making, both in the pre-optimization and in the post-processing phase.

>> License and role management streamlined



>> Efficient license handling for workflow and design space



mF2016 news:

mF license contains two separated Workflow and DesignSpace keys, which can be enabled/disabled

Advantage:

Two users can simultaneously access same mF license, working on the two environments (keys) separately

mF
modeFRONTIER

mP
modePROCESS

mS
modeSPACE





EXPLORE DESIGN PERFECTION



mf₂₀₁₆ **modeFRONTIER**

Data Space

esteco.com



>> Automatic RSM Training mode

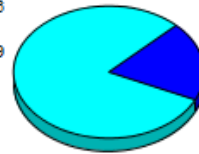
Going straight from data to RSM with **less clicks** and **less parameter settings**

1. Choose the Table

Name	Size	Type
Designs Table	3113	
Designs Table_Training	36	
Designs Table_Validation	4	
pareto	90	

Selected Table

Total	36
Real	7
Real(Broken)	29
Virtual	0
Virtual(Broken)	0
Error(Real)	0
Error(Virtual)	0



Choose output variable

☒ def
☒ stress
☒ weight

Choose input variable

☒ a
☒ b
☒ c
☒ dens

Choose the algorithm

☐ Polynomial SVD
☐ Stepwise Regression
☐ Shepard - K-Nearest
☐ Kriging
☐ Anisotropic Kriging

☒ Enable RSM validation - Criterion for favorite selection: Mean Normalized Error

Validation Config

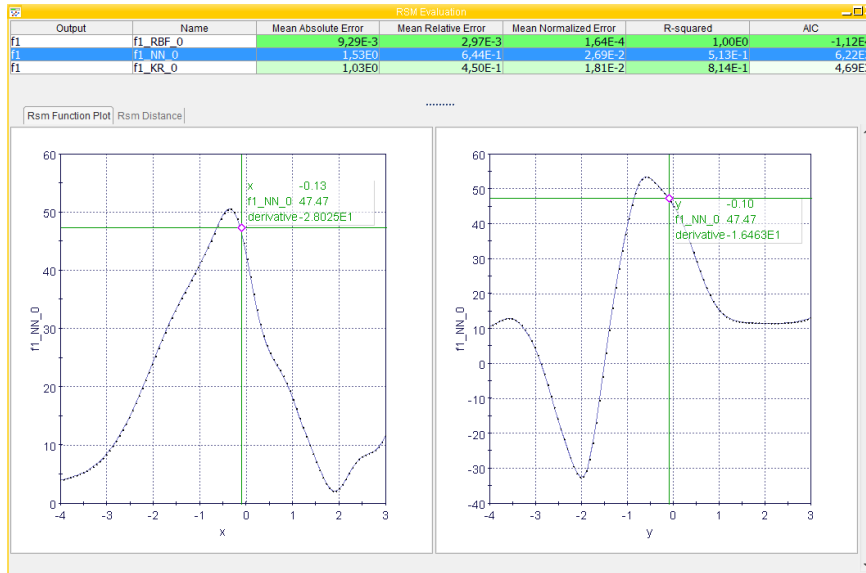
☐ Use existing table for validation Robust Designs Table

guided training process

- ✓ Saving time
- ✓ Easier and faster editing
- ✓ Manual RSM training wizard still available

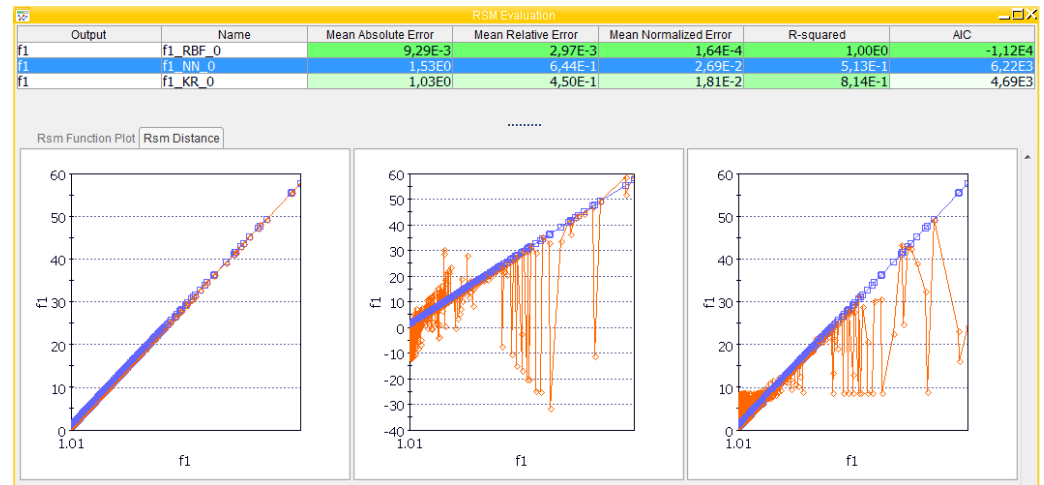


>> RSM Evaluation chart

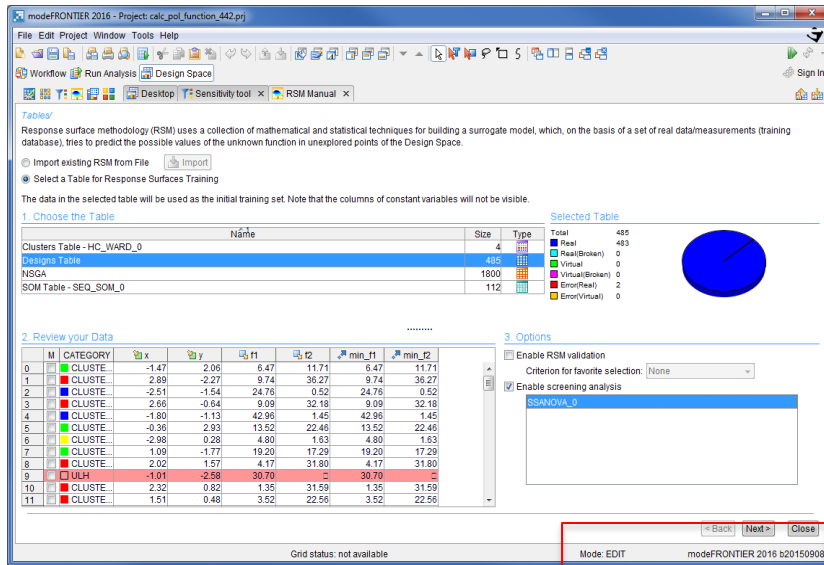


All-in-one chart showing relevant information for the quality evaluation of many RSMs

Useful to compare multiple RSMs, selecting the best model



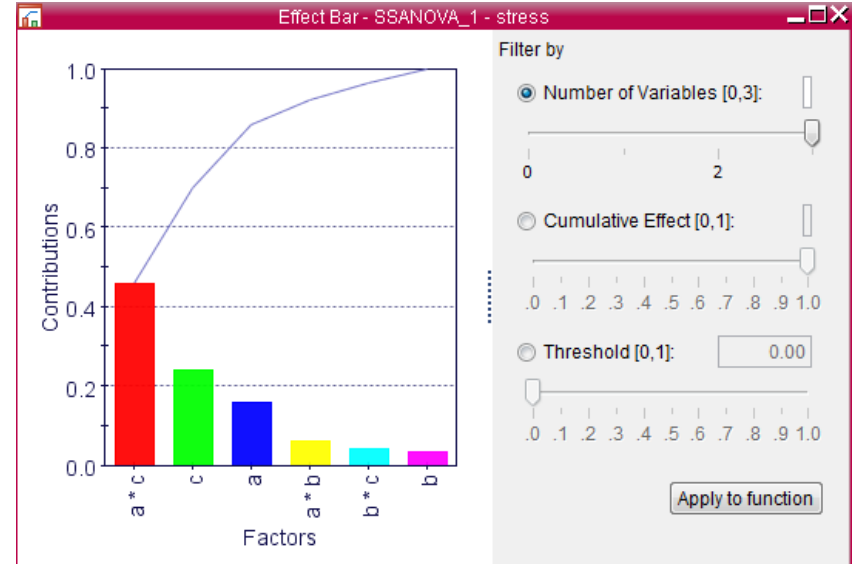
>> Sensitivity Analysis tool



✓ Efficient with **scarce** and **not factorial** database

✓ Detect **non-linear** and **interaction** effects

Variable screening based on **SS-ANOVA** >> detects the most important input variables in a process





EXPLORE DESIGN PERFECTION



mf₂₀₁₆ **modeFRONTIER**

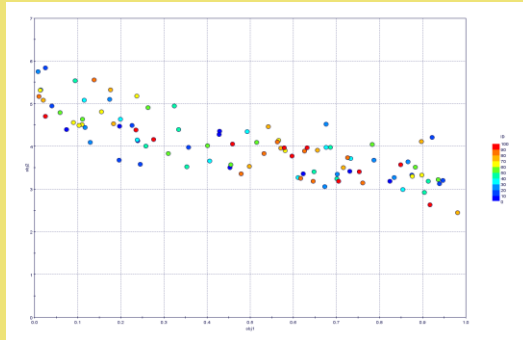
Process & Optimization

esteco.com



>> pilOPT: self-adapting one-click optimizer

pilOPT



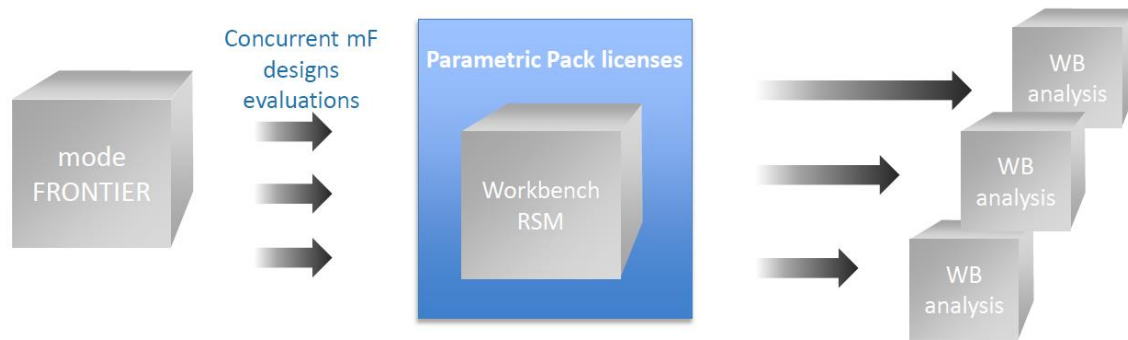
The new self-adapting one-click optimization algorithm

Improved pilOPT release:

- ✓ responding to a **wider variety** of engineering designs problems
- ✓ increased performance with **single-objective** problems
- ✓ better **exploitation of computational** resources
- ✓ effective handling of problems with **discrete** variables.

>> Integration node – Ansys WB Parametric Pack

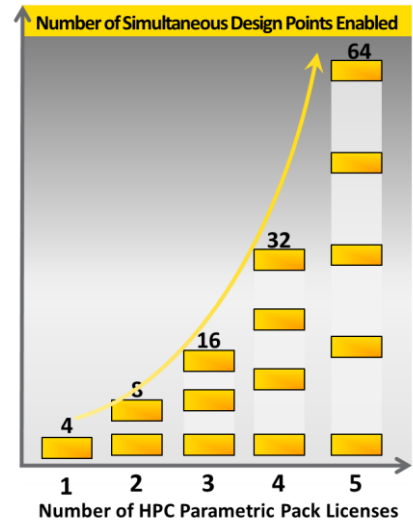
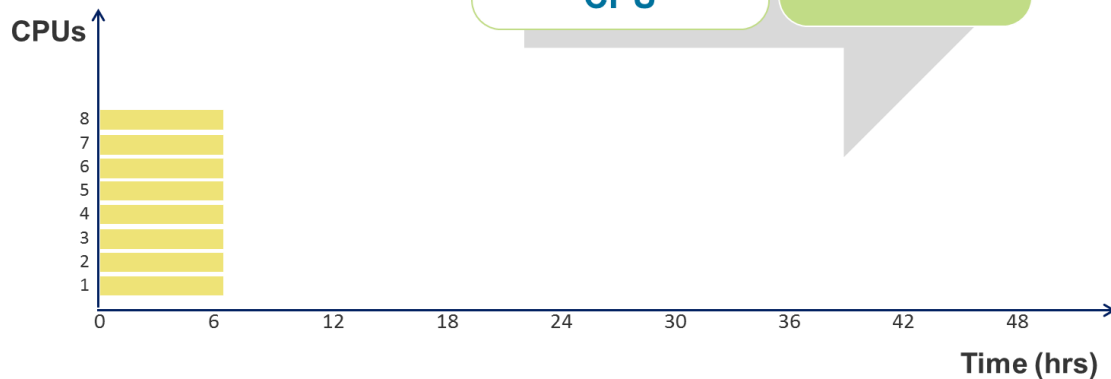
modeFRONTIER 2016 supports the HPC license consumption scheme from Ansys Workbench



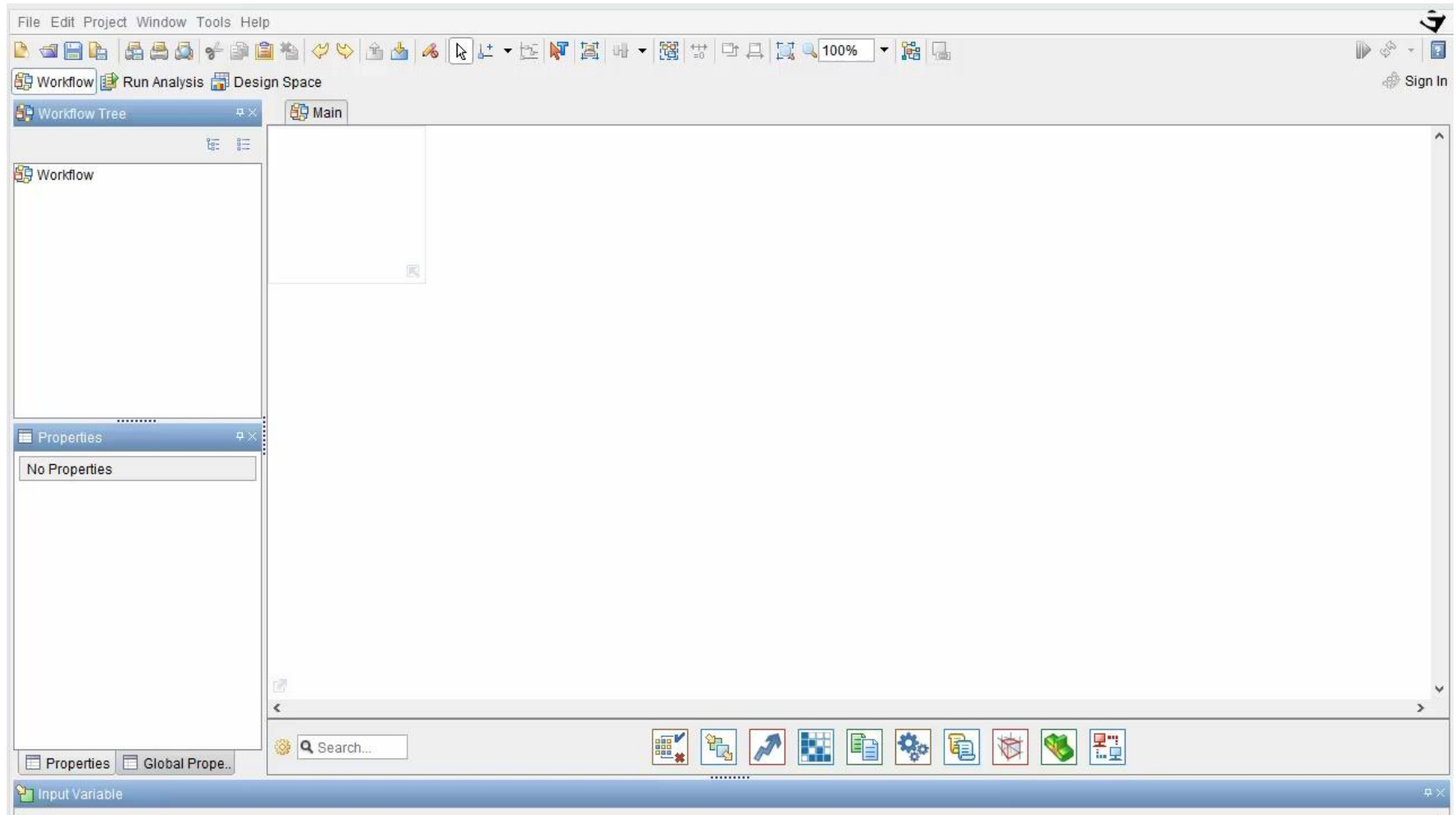
modeFRONTIER
submitting designs
through **2 ANSYS HPC
parametric packs**

**concurrent
execution of 8
designs on 1
CPU**

**6:15hr
total time**



>> ANSYS direct interface in modeFRONTIER



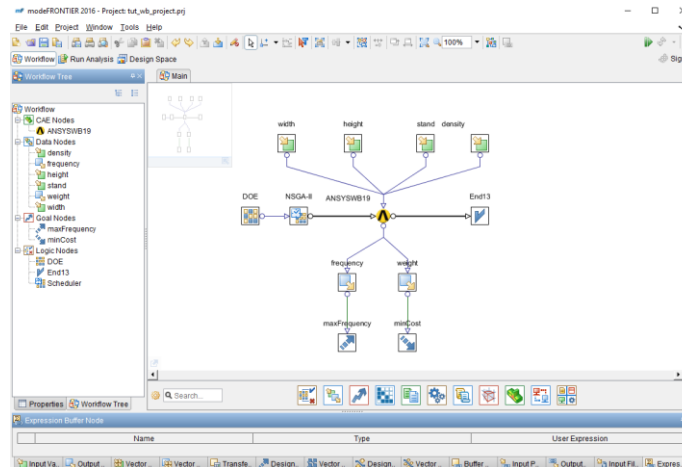
>> Ansys Integration node - advantages

>> fully exploit the **process automation** capabilities of modeFRONTIER in combination with the accuracy of the ANSYS multiphysics solvers

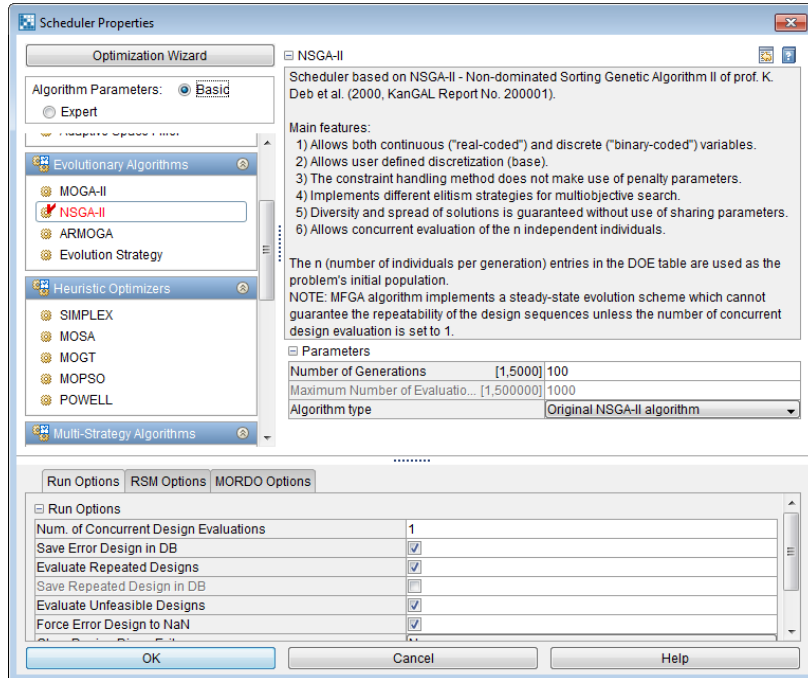
>> get **optimization results before**
and dedicate more time to post
processing and data analysis

>> **Multiple concurrent design evaluations**
without checking out additional
Workbench licenses

>> save on HPC setup costs

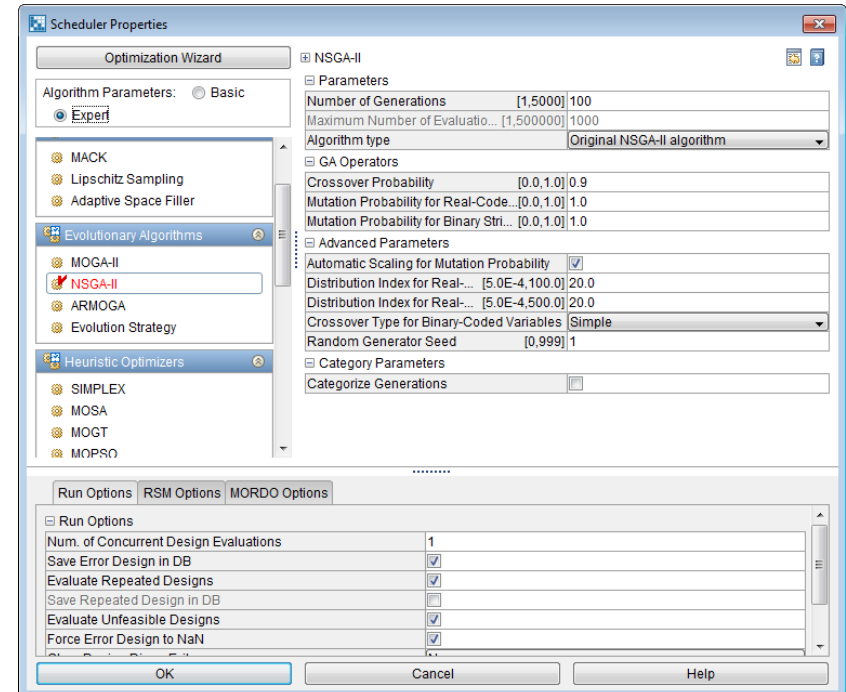


>> Basic and Expert mode



Basic mode: easy set-up of only essential algorithm parameters

Expert mode: edit advanced algorithm parameters



>> Automatic Setup Algorithms

We have expanded our selection of One-Click Optimizers from the adaptive multi-strategy pilOPT to also include **automatic single-parameter setup** versions of our classic algorithms MOGA-II and MOPSO.

No DOE required – the chosen algorithm generates it automatically.

Only one parameter is required – **Number of Design Evaluations**. Population size and number of iterations/generations computed according to the problem characteristics.

MOGA-II and MOPSO are also available in the classic Manual setup mode in which all parameters are exposed.

Evolutionary Algorithms

- ☒ MOGA-II
- ☐ NSGA-II
- ☐ ARMOGA
- ☐ Evolution Strategy

Heuristic Optimizers

- ☐ SIMPLEX
- ☐ MOSA
- ☐ MOGT
- ☒ MOPSO
- ☐ POWELL

MOGA-II

Algorithm Configuration: Automatic

Number of Evaluations: [1,500,000] 5000

MOGA-II

Algorithm Configuration: Manual

Parameters

Number of Generations: [1,5000] 100

Algorithm Type: MOGA - Generational Evolution

GA Operators

Probability of Directional Cross-Over	[0.0,1.0]	0.5
Probability of Selection	[0.0,1.0]	0.05
Probability of Mutation	[0.0,1.0]	0.1
DNA String Mutation Ratio	[0.0,1.0]	0.05

Advanced Parameters

Elitism	Enabled
Treat Constraints	Penalising Objectives
Reject Input-Unfeasible Designs	<input type="checkbox"/>
Maximum Number of Rejections	[1,999] 100
Random Generator Seed	[0,999] 1

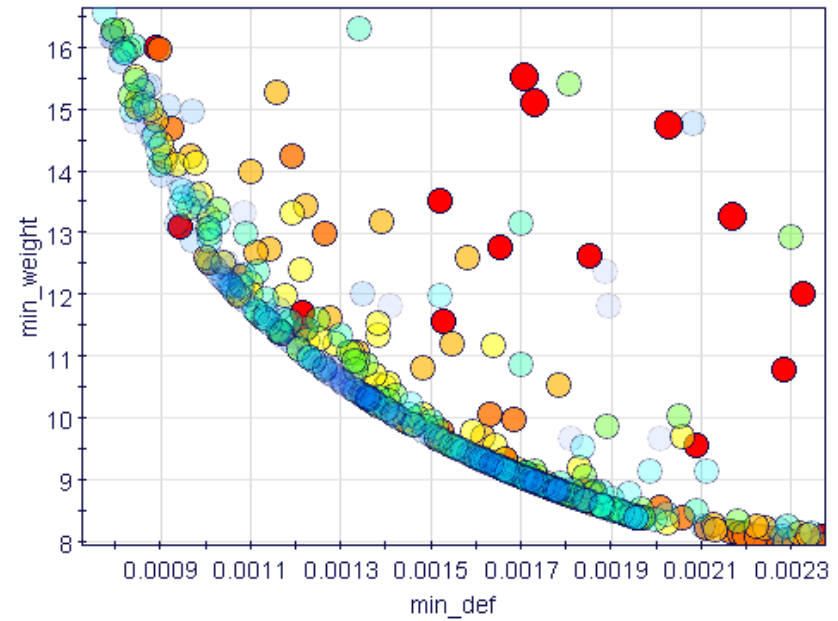
Category Parameters

Categorize Generations	<input type="checkbox"/>
Categorize Operators	<input type="checkbox"/>

>> New MOPSO Algorithm

Good alternative to Genetic Algorithms because it has a **higher convergence rate** if the evaluations require greater computational effort.

All parameters are exposed so the user can tune them to adapt the MOPSO performance to their problems.



Main features:

- ✓ Uses **elitism** – the best solutions are stored in the elite set and updated at each iteration
- ✓ **Steady-state evolution** - enables the saturation of all evaluation threads
- ✓ At each iteration particles change their position following **three types of guides**: the *personal best* position of the whole run, the position of the best particle in the *neighborhood* and the closest particle in the *elite* set.

The new MOPSO has shown **better results** than the previous version in all cases it was tested on.



Available in the Automatic and Manual mode.

PLORE DESIGN PERFECTION



mf₂₀₁₆ **modeFRONTIER**

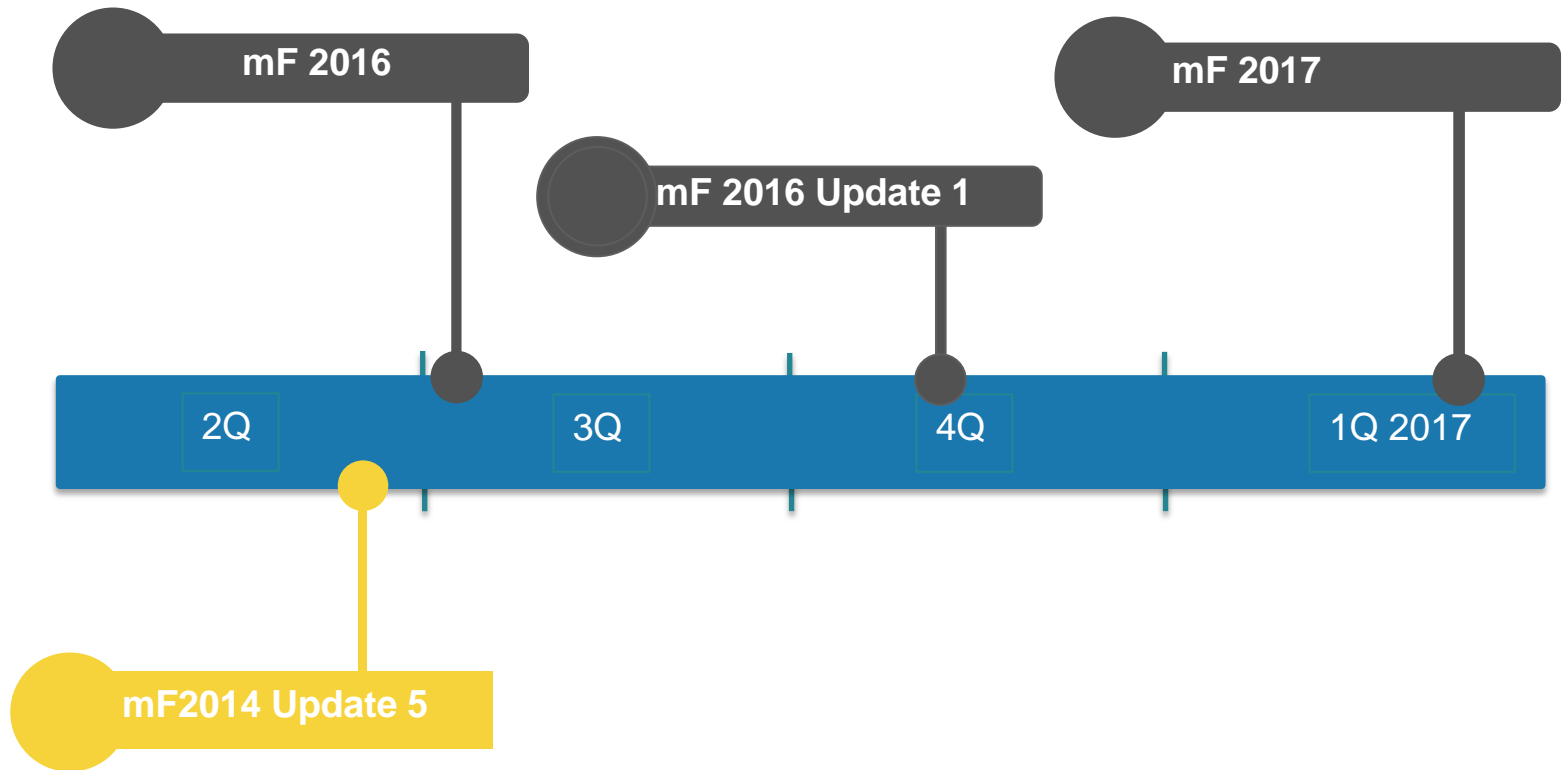
Product roadmap

esteco.com





modeFRONTIER product roadmap



>> modeFRONTIER 2014-2016 transition

mF2014 → mF2016

- ✓ mF2014 product line will be supported until end of 2017
- ✓ mF2014 compatible with mF2016 license files
- ✓ It will be possible to install mF2016 and mF2014 together on the same machine
- ✓ mF2016 will open mF4.5 (and mF2014) projects





EXPLORE DESIGN PERFECTION



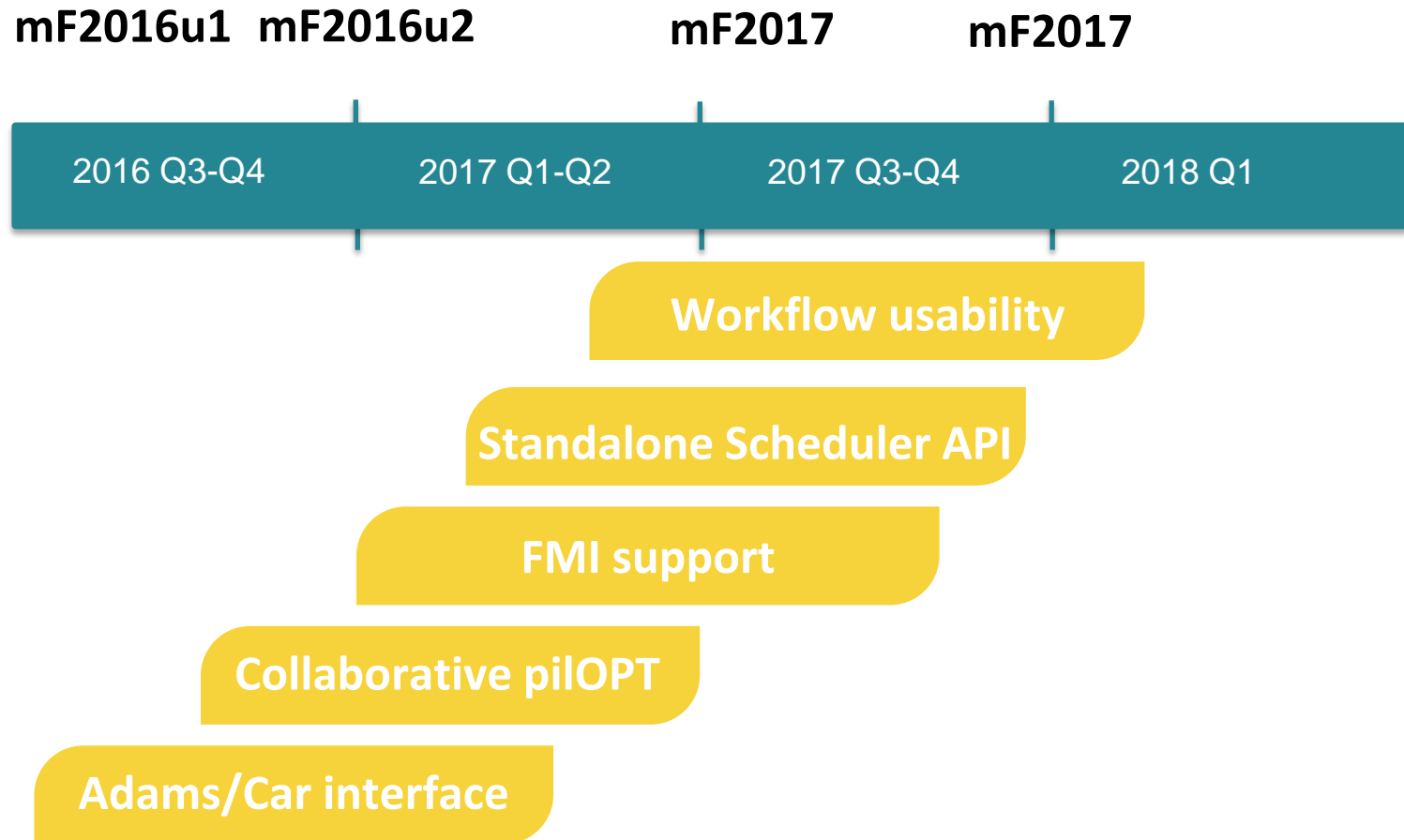
mf₂₀₁₆ ***modeFRONTIER***

Product line

esteco.com



modeFRONTIER 2016 development plan





EXPLORE DESIGN PERFECTION



modeFRONTIER

Looking forward

esteco.com





New Interface Design

The interface features a top toolbar with icons for File, Workflow, Run Analysis, and Design Space. Below this is a secondary toolbar with icons for various analysis tools like Table Creation, DOE Creation, Sensitivity Analysis, RSM Training Tools, Multi-Variate Analysis, Multi-Criteria Decision Making, Visible Chart Graphics, and Chart Graphics. The main workspace is divided into several panels: Explorer Tree on the left, Designs Table in the center, Bubble 4D Chart on the right, and Properties on the far right. A bottom toolbar contains icons for Design Charts, Statistical Analysis, Distribution Analysis, Sensitivity Analysis, RSM Charts, MCDM Charts, SOM Charts, Cluster Analysis, PCA Charts, and MDS Charts.

Designs Table

ID	Category	InputVar1	InputVar2	Obj1	Obj2
1	Sobol, Cust...	58.56984	58.56984	58.56984	58.56984
2	piIOPT	58.56984	58.56984	58.56984	58.56984
3	piIOPT	58.56984	58.56984	58.56984	58.56984
4	Pareto, Unf...	58.56984	58.56984	58.56984	58.56984
5	Pareto, Bad...	58.56984	58.56984	58.56984	58.56984
6	Pareto	58.56984	58.56984	58.56984	58.56984
7	Pareto	58.56984	58.56984	58.56984	58.56984
8	Pareto	58.56984	58.56984	58.56984	58.56984
9	Pareto, Unf...	58.56984	58.56984	58.56984	58.56984
10	Pareto, Unf...	58.56984	58.56984	58.56984	58.56984
11	Pareto, Unf...	58.56984	58.56984	58.56984	58.56984

Multi-History Chart

Variable Y

Variable X

Bubble 4D Chart

Variable Y

Variable X

Categories

- ✓ Contemporary Look & Feel and Color Uniformity
- ✓ Icons with clearer meanings
- ✓ Consideration for usability issues
- ✓ Replacement of the old toolbar with a new one with larger icons and descriptions



>> Workflow Wizard

Quick workflow building in one dialog:

1. Select the software you want to integrate (Search function available).
2. Choose a model file and Load the Parameters contained in it.
3. Use checkboxes to select the input and output parameters in the model you want to optimize with modeFRONTIER. You can also define the range of variation of inputs.
4. (Optional) Define the Objectives and Constraints
5. You can then close the wizard and go to the workflow or click Optimize and at once start the project execution.

The screenshot shows the 'Workflow Creation Wizard' dialog box with the following sections:

- 1. Select integrated software:** A search bar and a row of software icons including Processing Nodes, Application Nodes, Script Nodes, CAD Nodes, CAE Nodes, Networking Nodes, Catia, Creo Parametric, NX, SolidWorks, SolidWorks Flow Simulation, and Spaceclaim.
- 2. Configure Catia Node Properties:** A section for choosing a model file to optimize. It includes a 'Configuration' tab, a 'Node Name' field, a 'Model File' field with a folder icon, and buttons for 'Load Parameters' and 'Open CATIA Model'.
- 3. Create Variables:** A section for selecting input and output parameters. It includes buttons for 'Expand Tree', 'Collapse Tree', 'Reload Parameters', 'Filter Parameters', 'Link All', and 'Unlink All'. Below these are 'Inputs' and 'Outputs' tabs, a search bar, and a table for defining variable ranges.
- 4. Define Objectives and Constraints:** A section for creating objectives and constraints. It includes buttons for 'Add', 'Remove', 'Select All', and 'Deselect All'. Below these are 'Objectives' and 'Constraints' tabs, and a table for defining objectives.

The 'Create Variables' section includes a table for defining variable ranges:

	Lower Bound	Upper Bound	Base	Step
InputParameter	-1,000.00	1,000.00		
InputParameter	-1,000.00	1,000.00		
InputParameter	-1,000.00	1,000.00		
InputParameter	-1,000.00	1,000.00		
InputParameter	-1,000.00	1,000.00		
InputParameter	-1,000.00	1,000.00		
InputParameter	-1,000.00	1,000.00		
InputParameter	-1,000.00	1,000.00		

The 'Define Objectives and Constraints' section includes a table for defining objectives:

	Expression	Type
Objective1	x+y	Minimize
Objective2	x*y	Minimize

At the bottom right, there are buttons for 'Optimize' and 'Create Workflow'.





登陆www.idaj.cn申请试用和资料



EXPLORE DESIGN PERFECTION

