



EXPLORE DESIGN PERFECTION



modeFRONTIER

The Integration Platform for Multiobjective
and Multidisciplinary Optimization

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Product manager modeFRONTIER



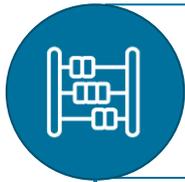
Your True Partner for
CAE × CFD
ICSC2016



>> Multiobjective Optimization with modeFRONTIER

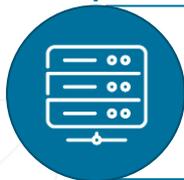
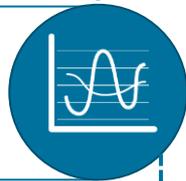
Multi-objective problems are solved using **sophisticated optimization algorithms**, which identify a set of **Pareto designs** whose objective functions are non-dominated by any other design among those tested.

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

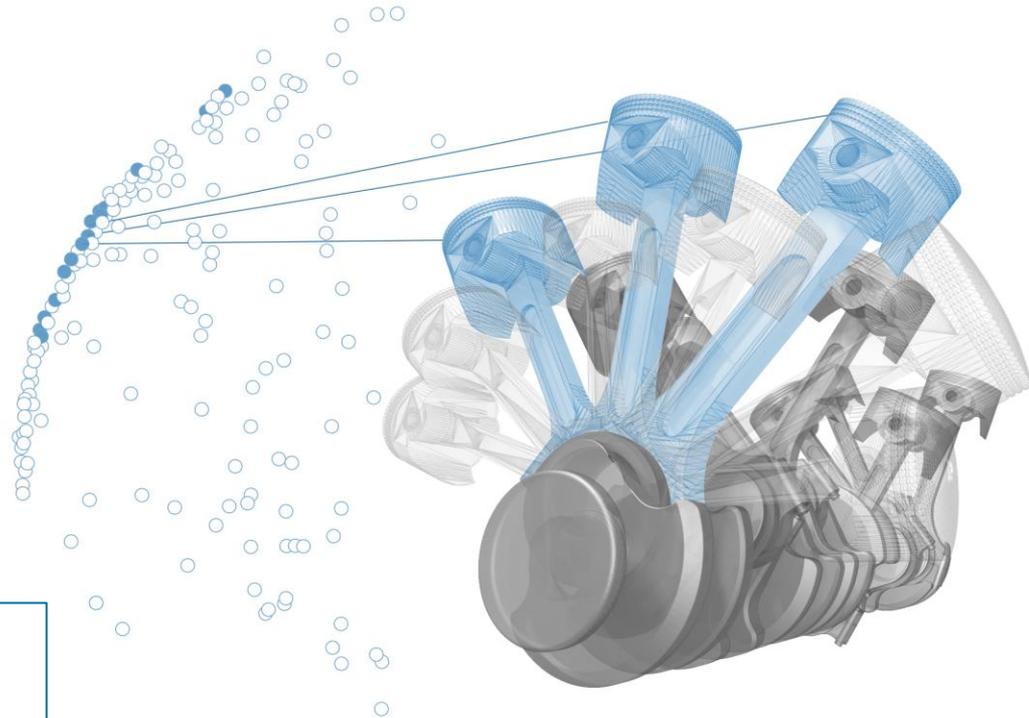


number, type and range of variables, objectives and constraints

reliability and robustness required

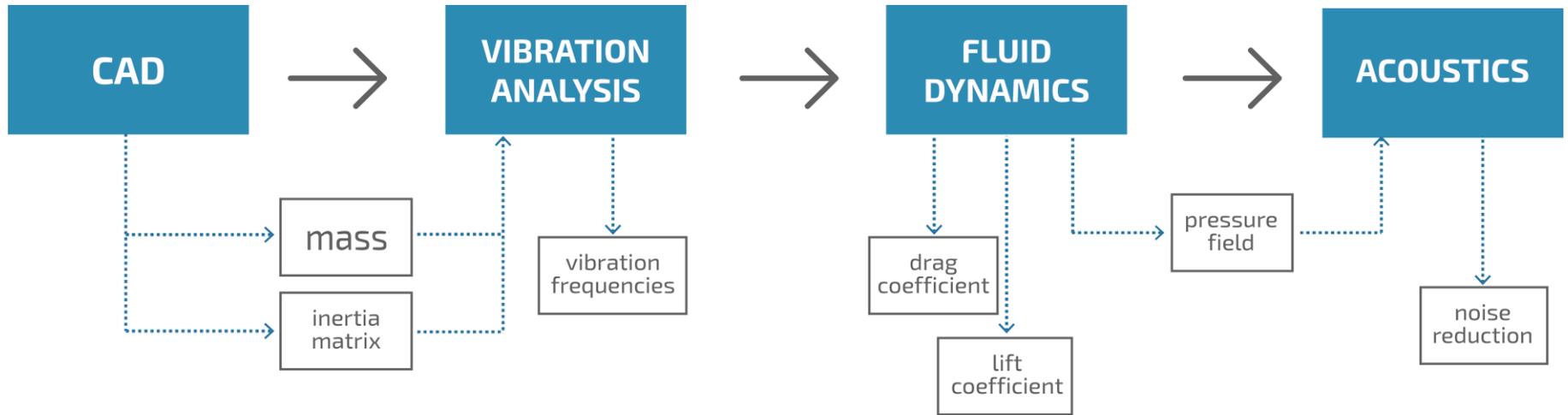


attainable computational resources



>> 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.

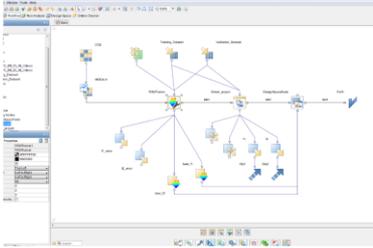


This **multidisciplinary approach** allows to exploit the **interaction** between the disciplines and determine the **global optimum solution**, instead of optimizing each discipline sequentially.



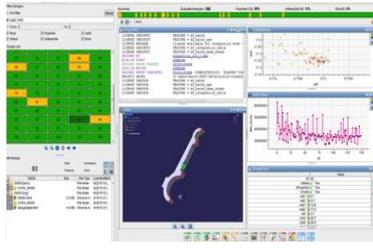
modeFRONTIER Technology

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



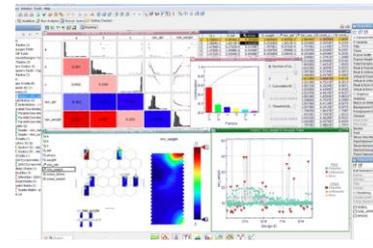
ACCESS THROUGH **mFmP**
modeFRONTIER modePROCESS

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**

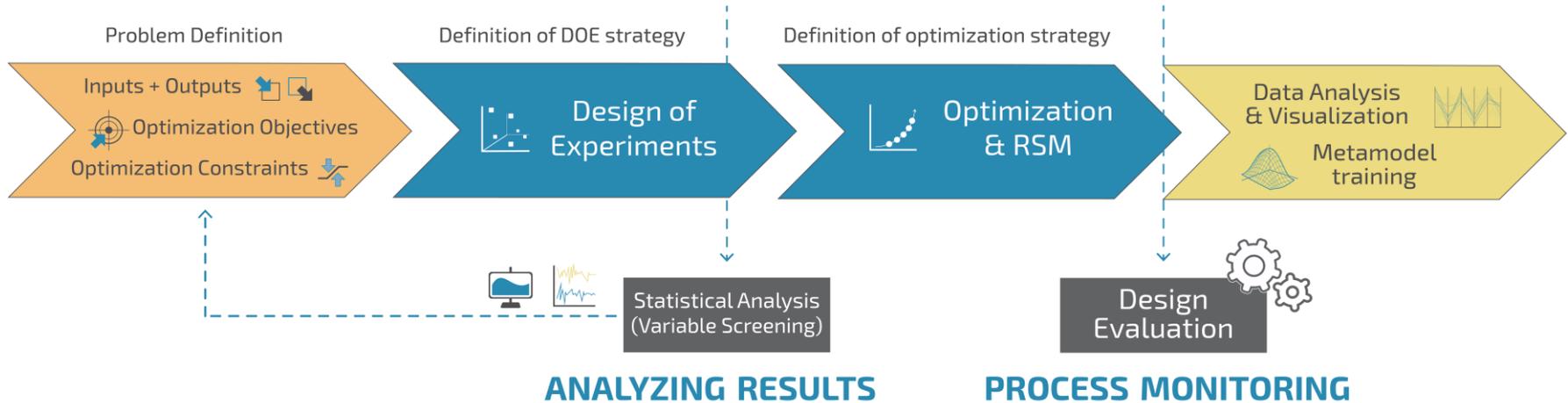


>> modeFRONTIER Process Flow



WORKFLOW BUILDING

ANALYZING RESULTS





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Concept

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**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





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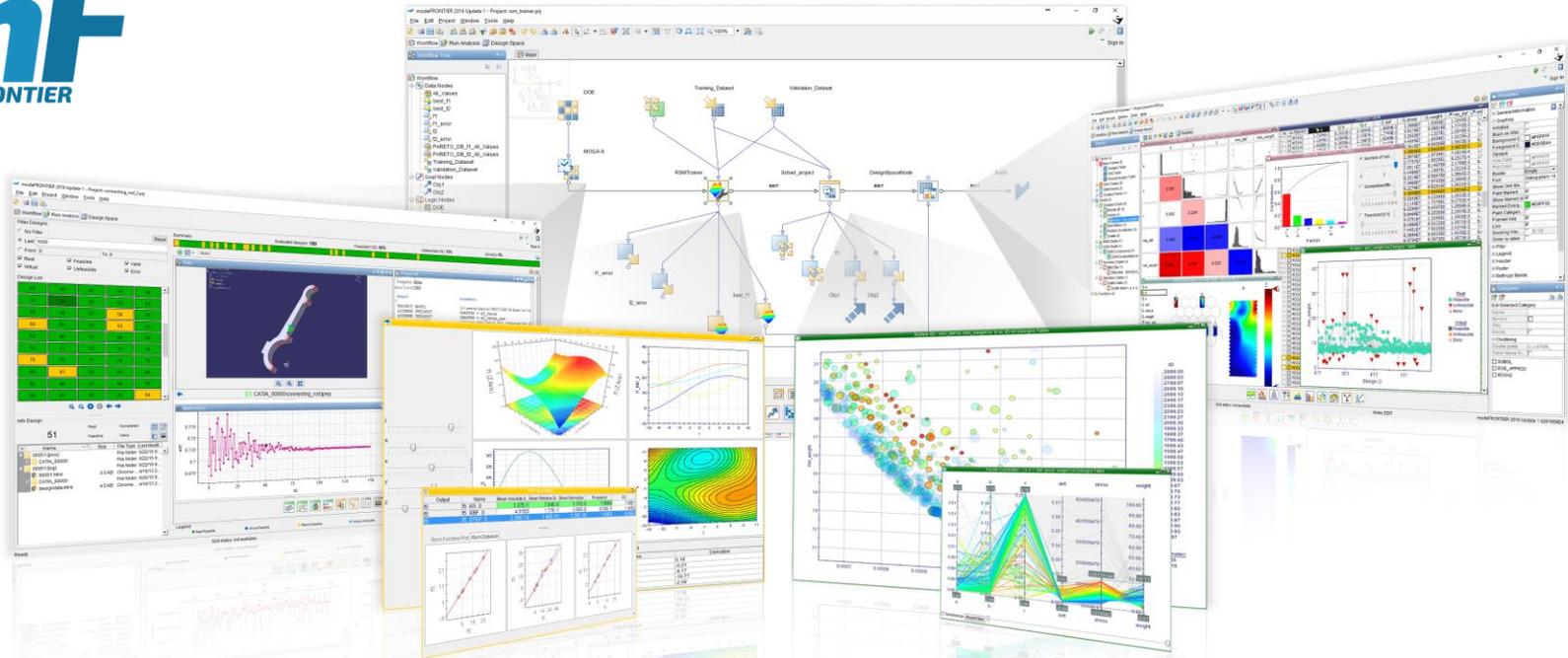


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Modules

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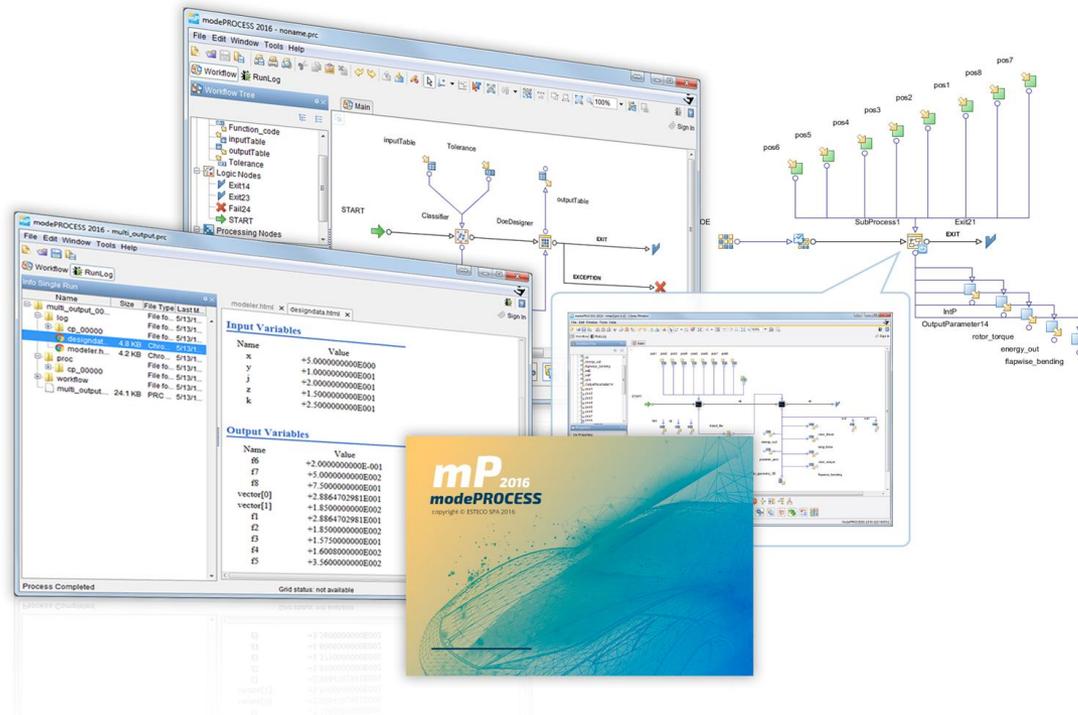




modeFRONTIER

Streamlines the design process with powerful workflows, innovative algorithms and sophisticated post-processing tools.

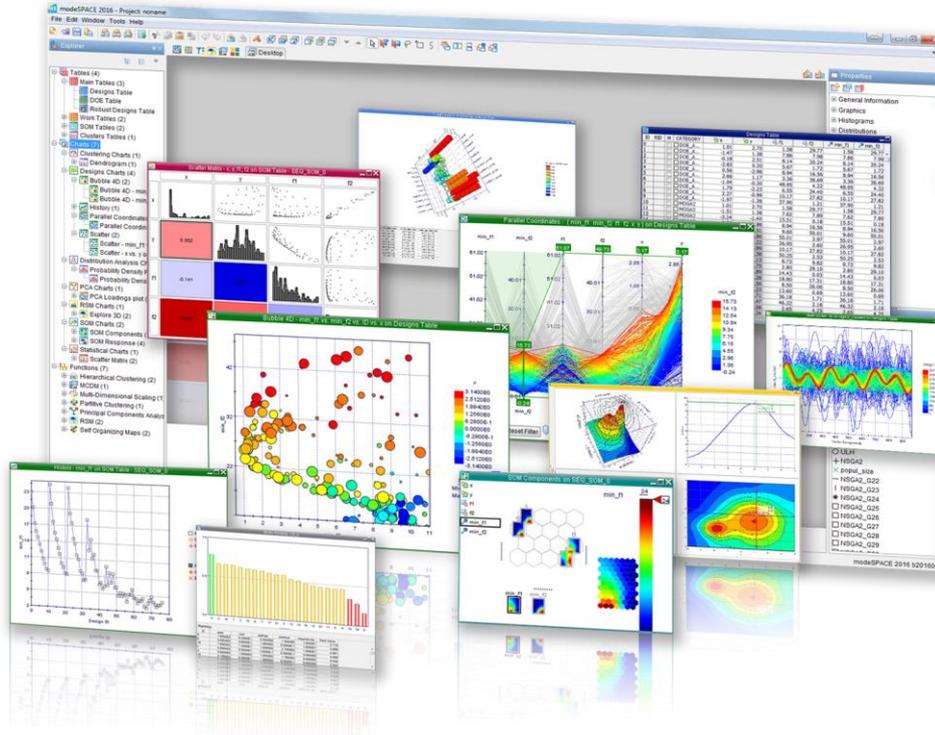
Its advanced capabilities for multidisciplinary design, keeps it at forefront of engineering technology.



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.

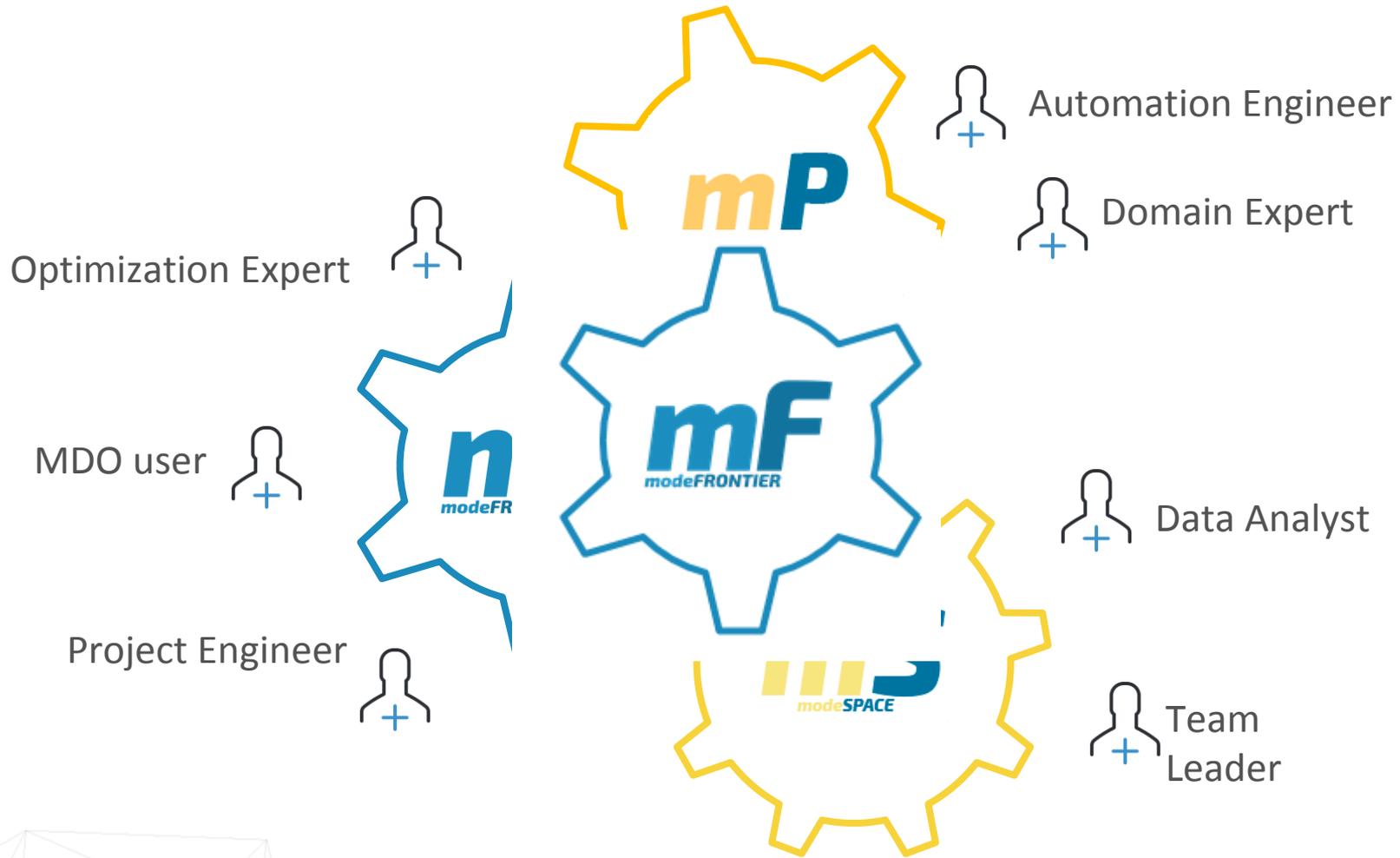




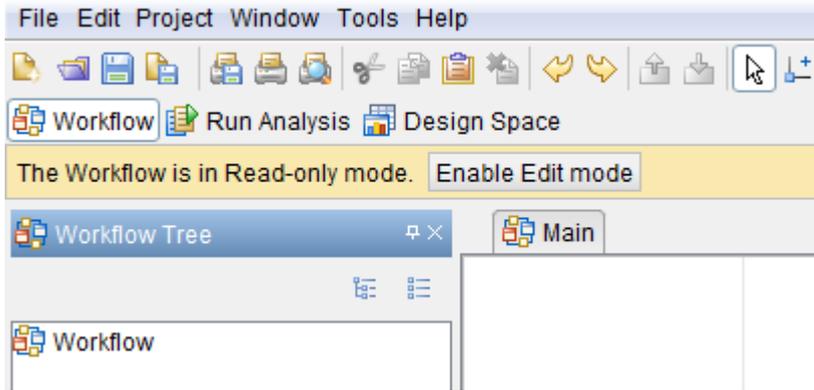
modeSPACE

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





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Data Space

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>> Automatic RSM Training mode

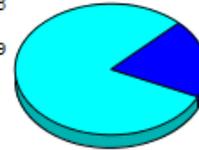
Going straight from data to RSM with **less clicks** and **less parameter settings**

1. Choose the Table

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

Selected Table

Total	38
Real	7
Real(Broken)	29
Virtual	0
Virtual(Broken)	0
Error(Real)	0
Error(Virtual)	0



Choose output variable Choose input variable Choose the algorithm

def
 stress
 weight

a
 b
 c
 dens

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

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

Validation Config

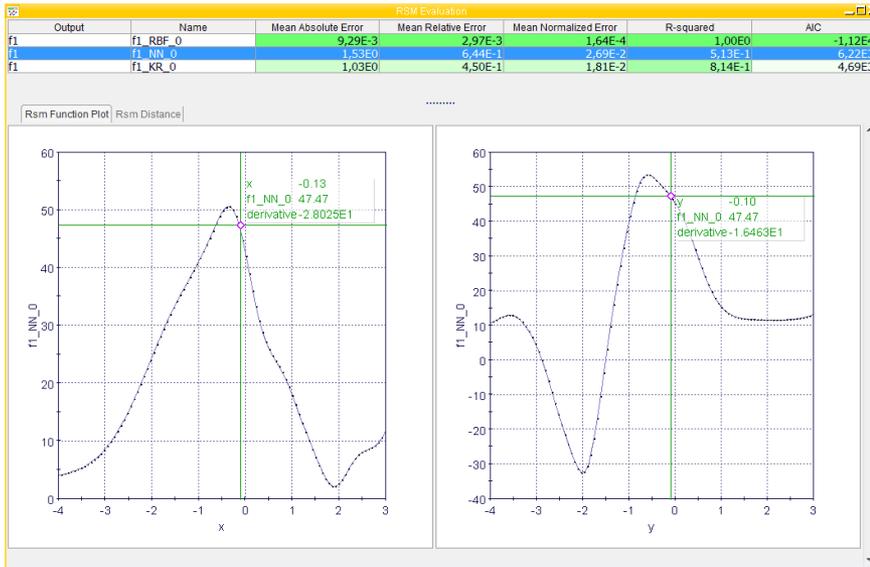
Use existing table for validation Robust Designs Table

guided training process

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

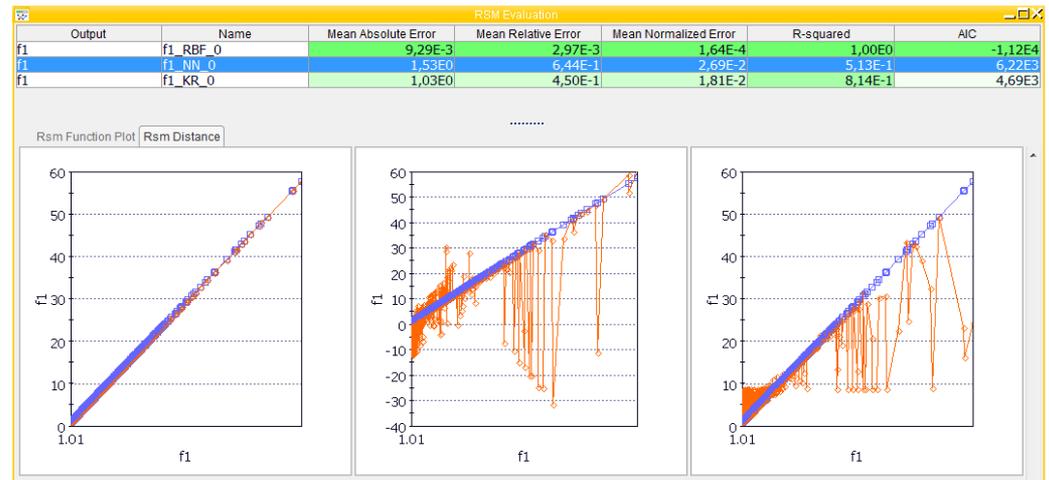


>> RSM Evaluation chart



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

modeFRONTIER 2016 - Project: calc_pol_function_442.prj

File Edit Project Window Tools Help

Workflow Run Analysis Design Space

Tables

Response surface methodology (RSM) uses a collection of mathematical and statistical techniques for building a surrogate model, which, on the basis of a set of real data/measurements (training database), tries to predict the possible values of the unknown function in unexplored points of the Design Space.

Import existing RSM from File Import

Select a Table for Response Surfaces Training

The data in the selected table will be used as the initial training set. Note that the columns of constant variables will not be visible.

1. Choose the Table

Name	Size	Type
Clusters Table - HC_WARD_0	4	
Design Table	485	
NSGA	1800	
SOM Table - SEQ_SOM_0	112	

Selected Table

- Total: 485
- Real: 483
- Real(Broken): 0
- Virtual: 0
- Virtual(Broken): 0
- Error(Real): 2
- Error(Virtual): 0

2. Review your Data

M	CATEGORY	x	y	f1	f2	min_f1	min_f2
0	CLUSTE	-1.47	2.06	6.47	11.71	6.47	11.71
1	CLUSTE	2.89	-2.27	9.74	36.27	9.74	36.27
2	CLUSTE	-2.51	-1.54	24.76	0.52	24.76	0.52
3	CLUSTE	2.66	-0.64	9.09	32.18	9.09	32.18
4	CLUSTE	-1.80	-1.13	42.96	1.45	42.96	1.45
5	CLUSTE	-0.36	2.93	13.52	22.46	13.52	22.46
6	CLUSTE	-2.96	0.28	4.80	1.63	4.80	1.63
7	CLUSTE	1.09	-1.77	19.20	17.29	19.20	17.29
8	CLUSTE	2.02	1.57	4.17	31.80	4.17	31.80
9	ULH	-1.01	-2.88	30.70	30.70	30.70	30.70
10	CLUSTE	2.32	0.82	1.35	31.59	1.35	31.59
11	CLUSTE	1.51	0.48	3.62	22.56	3.62	22.56

3. Options

Enable RSM validation

Criterion for favorite selection: None

Enable screening analysis

SSANOVA_0

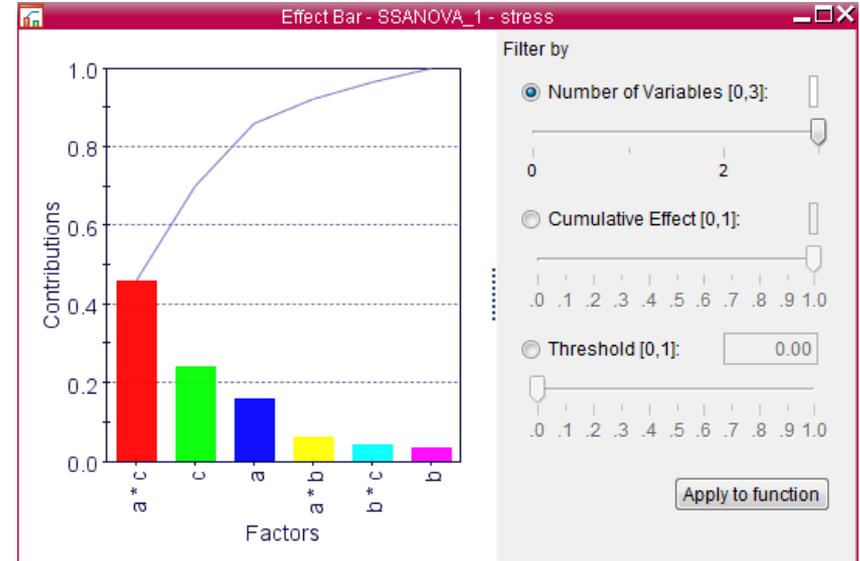
Grid status: not available

Mode: EDIT modeFRONTIER 2016 620150908

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

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

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





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Process & Optimization

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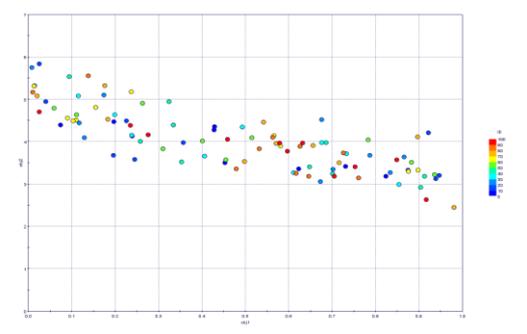


>> pilOPT: self-adapting one-click optimizer



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

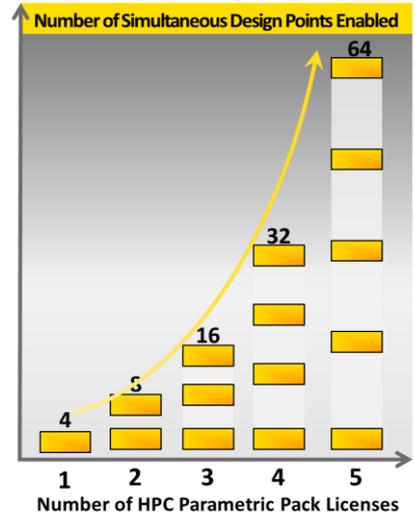
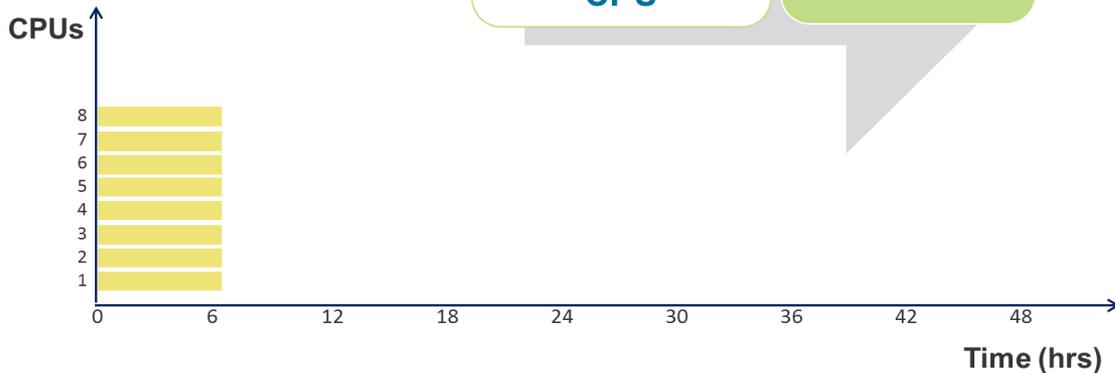
modeFRONTIER 2016 supports the HPC license consumption scheme from Ansys Workbench



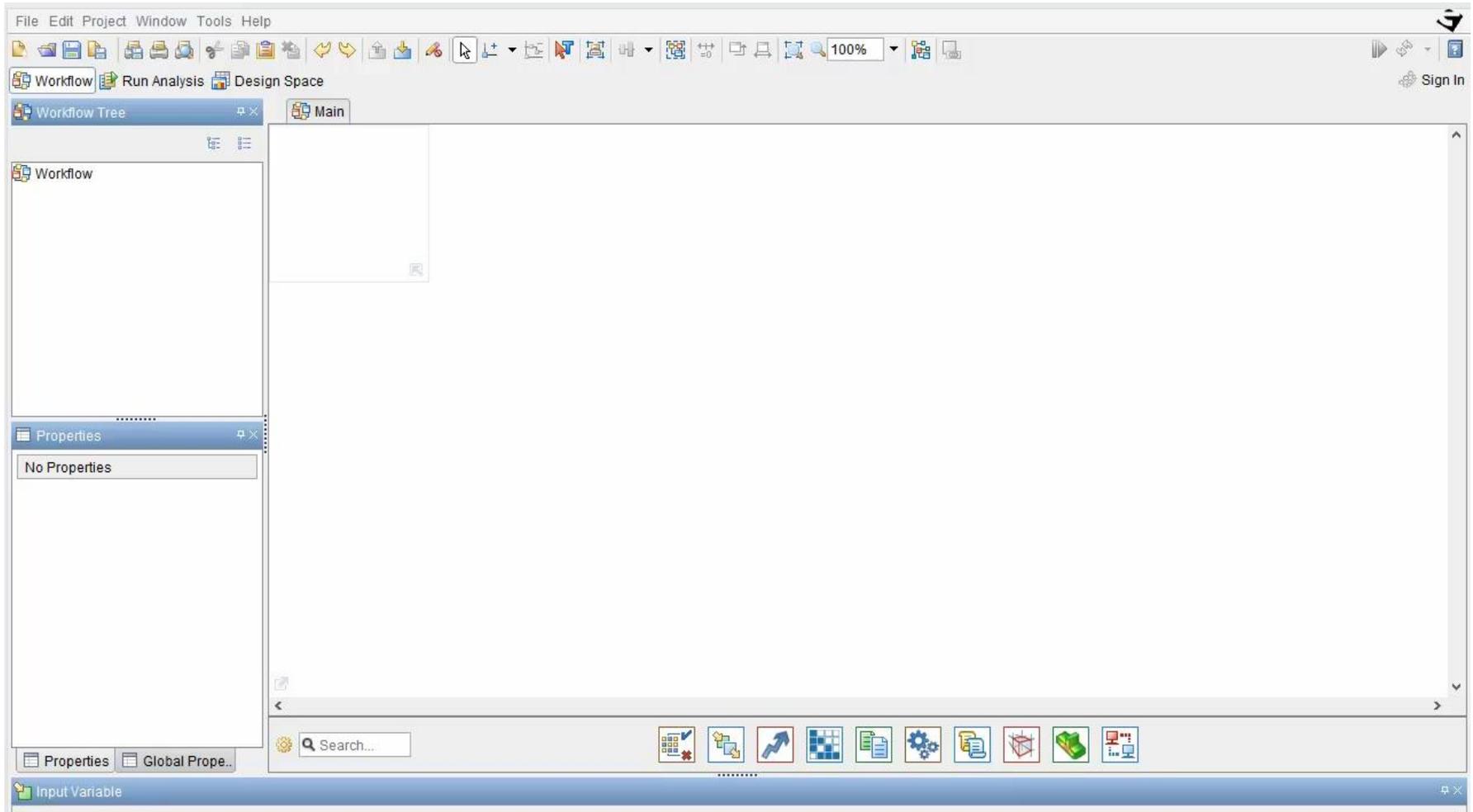
modeFRONTIER submitting designs through **2 ANSYS HPC parametric packs**

concurrent execution of 8 designs on 1 CPU

6:15hr total time



>> ANSYS direct interface in modeFRONTIER



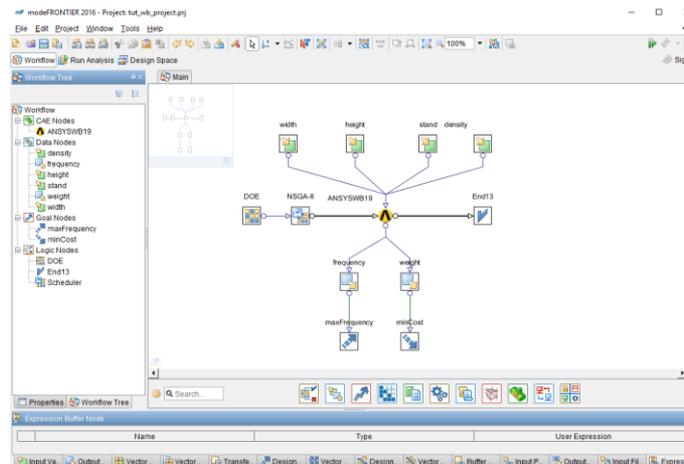
>> Ansys Integration node - advantages

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

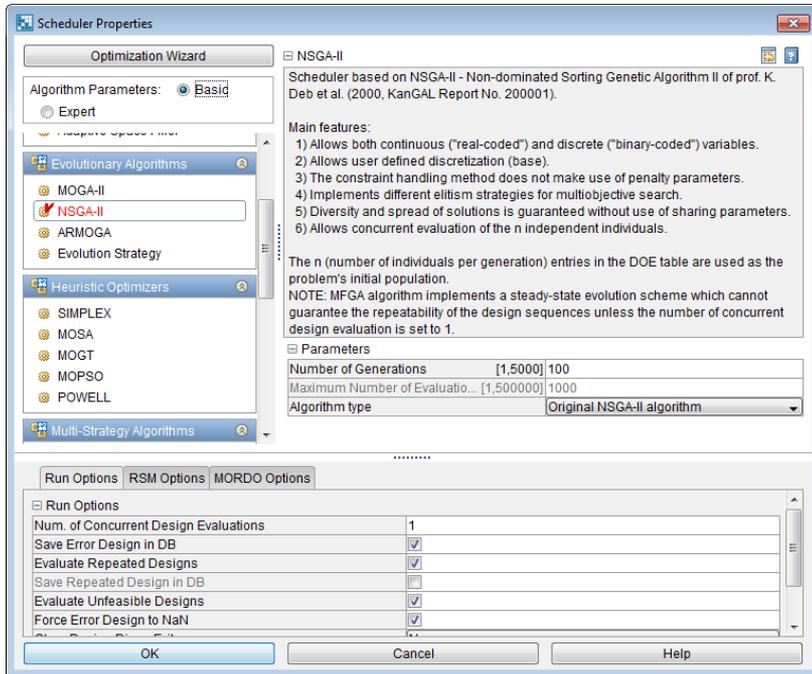
>> get **optimization results before** and dedicate more time to post processing and data analysis

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

>> **save on HPC setup costs**

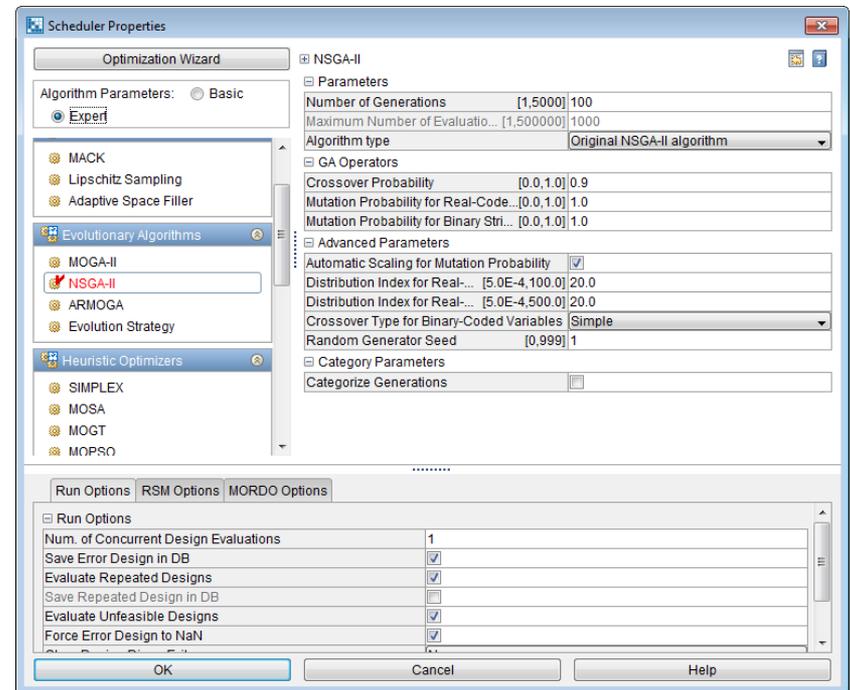


>> Basic and Expert mode



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.

The screenshot displays the software's optimizer selection and configuration interface. It is divided into two main sections: 'Evolutionary Algorithms' and 'Heuristic Optimizers'. In the 'Evolutionary Algorithms' section, 'MOGA-II' is selected. In the 'Heuristic Optimizers' section, 'MOPSO' is selected. The 'MOGA-II' configuration panel is shown in two states: 'Automatic' and 'Manual'.

Automatic Configuration:

- Algorithm Configuration: Automatic
- Number of Evaluations: [1,500000] 5000

Manual Configuration:

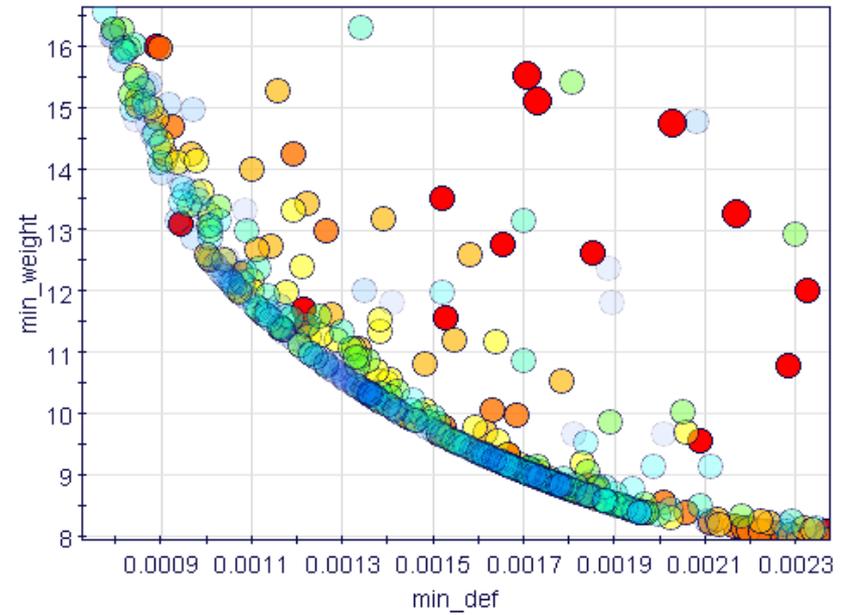
- Algorithm Configuration: Manual
- Parameters
 - Number of Generations: [1,5000] 100
 - Algorithm Type: MOGA - Generational Evolution
- GA Operators
 - Probability of Directional Cross-Over: [0.0, 1.0] 0.5
 - Probability of Selection: [0.0, 1.0] 0.05
 - Probability of Mutation: [0.0, 1.0] 0.1
 - DNA String Mutation Ratio: [0.0, 1.0] 0.05
- Advanced Parameters
 - Elitism: Enabled
 - Treat Constraints: Penalising Objectives
 - Reject Input-Unfeasible Designs:
 - Maximum Number of Rejections: [1, 999] 100
 - Random Generator Seed: [0, 999] 1
- Category Parameters
 - Categorize Generations:
 - Categorize Operators:



>> 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.



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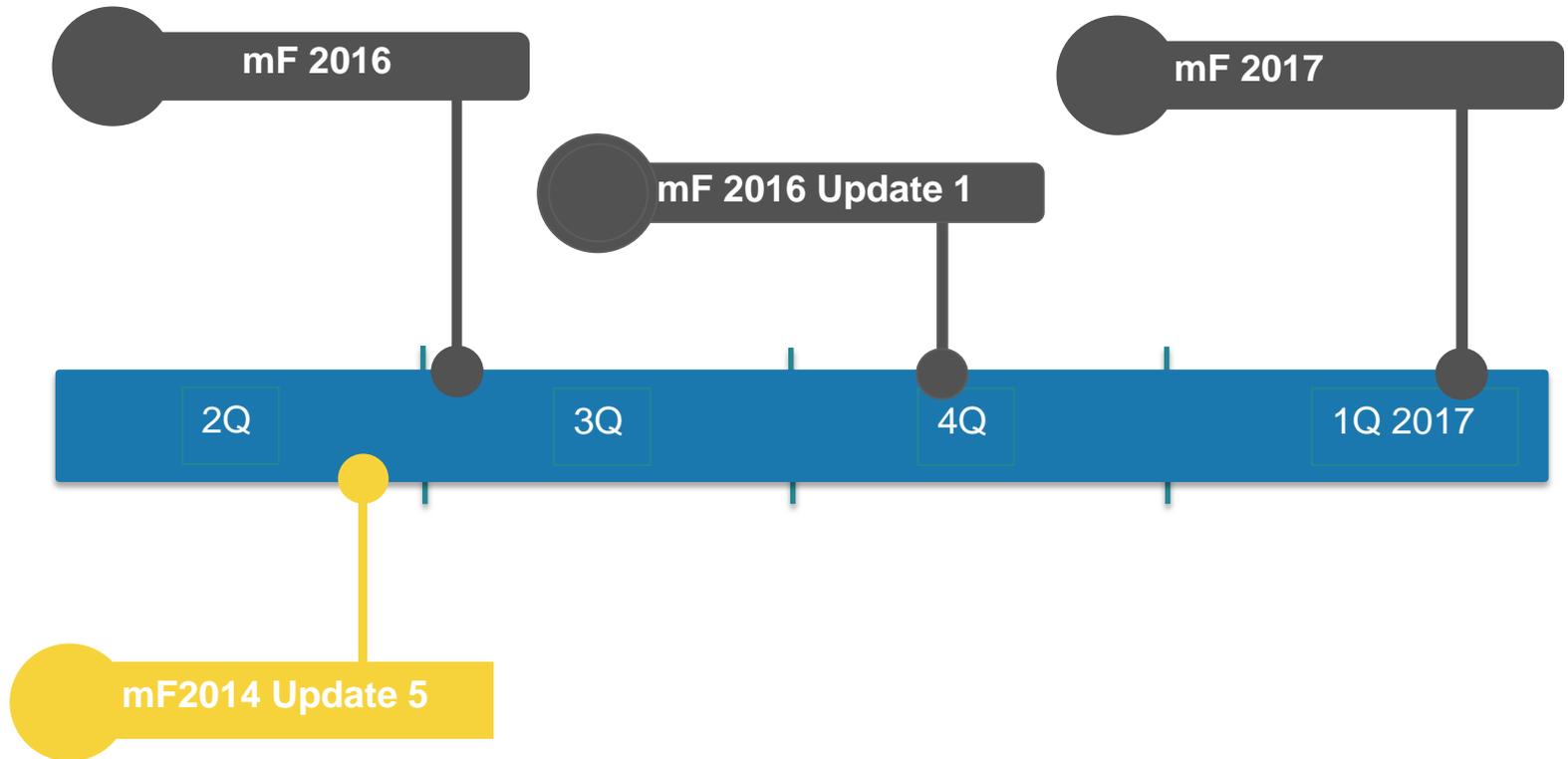
Product roadmap

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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





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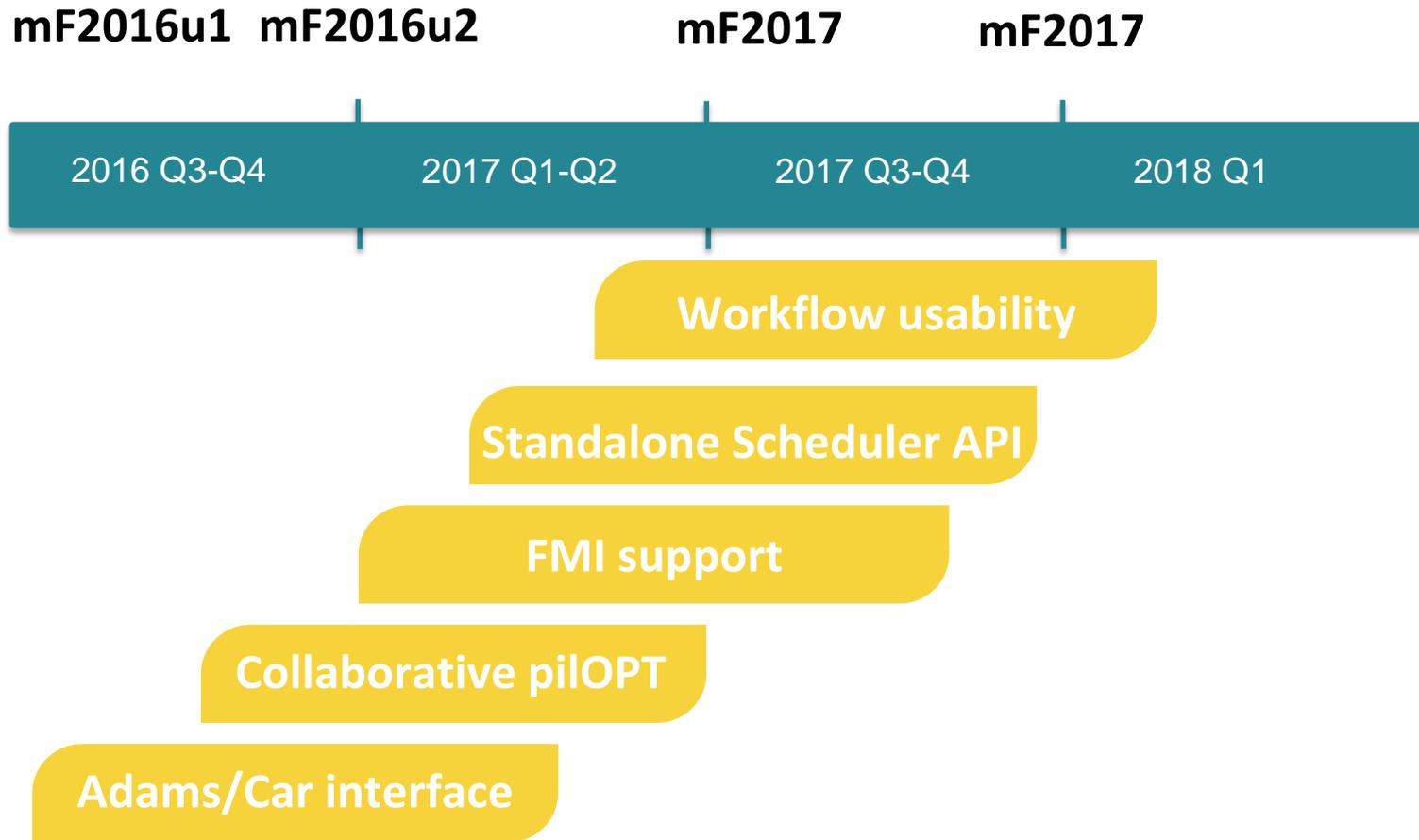
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Product line

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modeFRONTIER 2016 development plan





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Looking forward

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New Interface Design

ID	S	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

- ✓ 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





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