ESTECO
USERS' MEETING
NORTH AMERICA

um 2023

Elevate design optimization with ESTECO digital engineering technology

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VOLTA Product Manager

Challenges in the Model-based design process

- Products are complex system-of-systems
- Integration of multiple engineering disciplines
- Large number of simulation tools
- Collaboration among subject matter experts
- Geographically dispersed workforce and compute infrastructure

Untapped potential of improving design performance

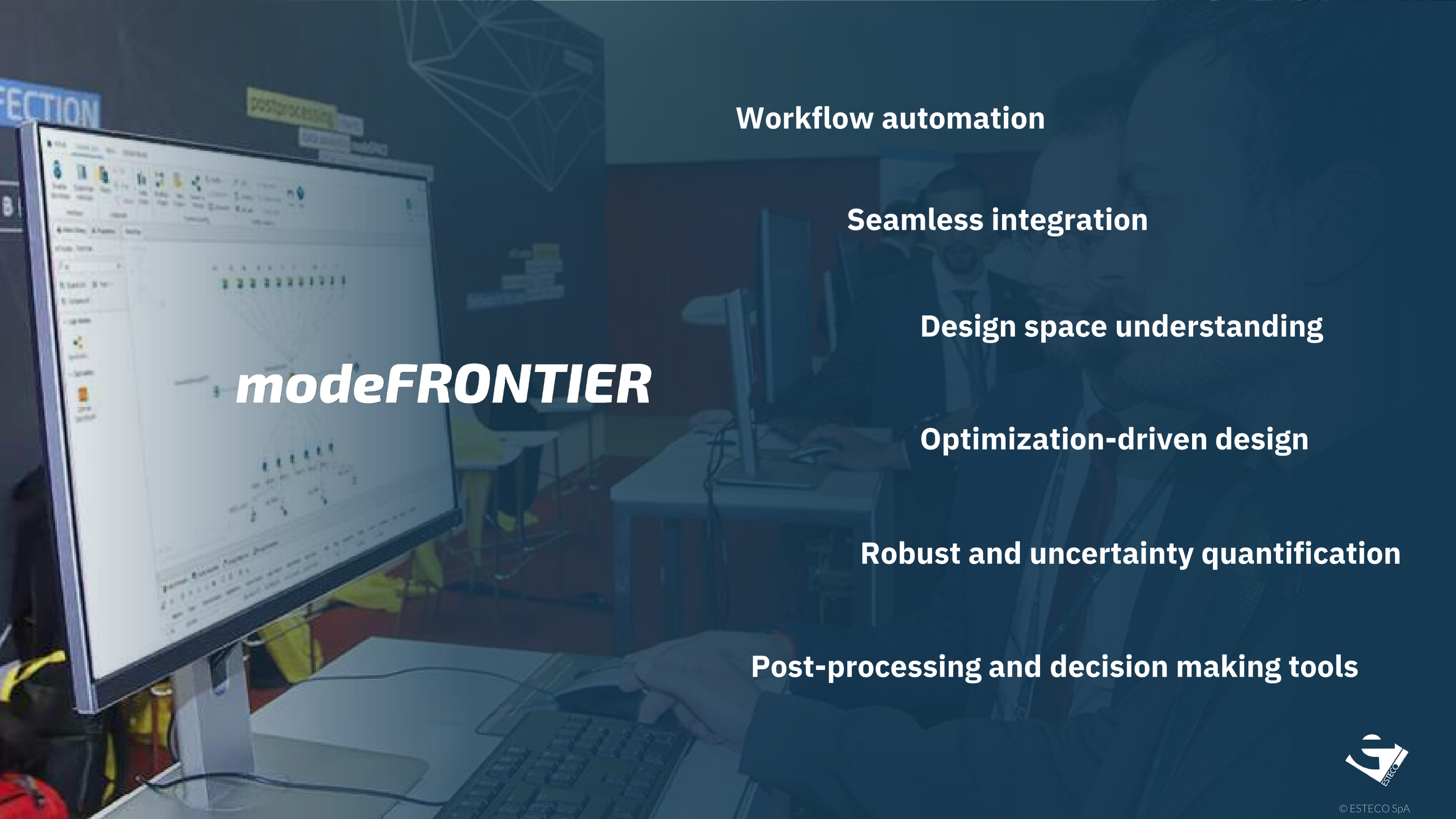
- Simulation still heavily relies on trial-and-error
- Manual or partially automated CAE workflows
- Design optimization requires expertise or significant investment of time
- The ability of simulation experts is limited

“3 out of 5 organizations consider a shortage of talent and a limited understanding of the benefits as a critical impediment towards adoption of AI/ML-based simulation.

NAFEMS and McKinsey & Company
Survey: The future of Simulation, 2023.

As your digital engineering initiative grows, what to expect from an optimization software?

- Lower the barriers to automating simulation workflows, and making them reusable
- Make it easy to set up multiple design optimization strategies with pre-configurable scenarios
- Democratize the use of automated simulations and design optimization across your organization



Workflow automation

Seamless integration

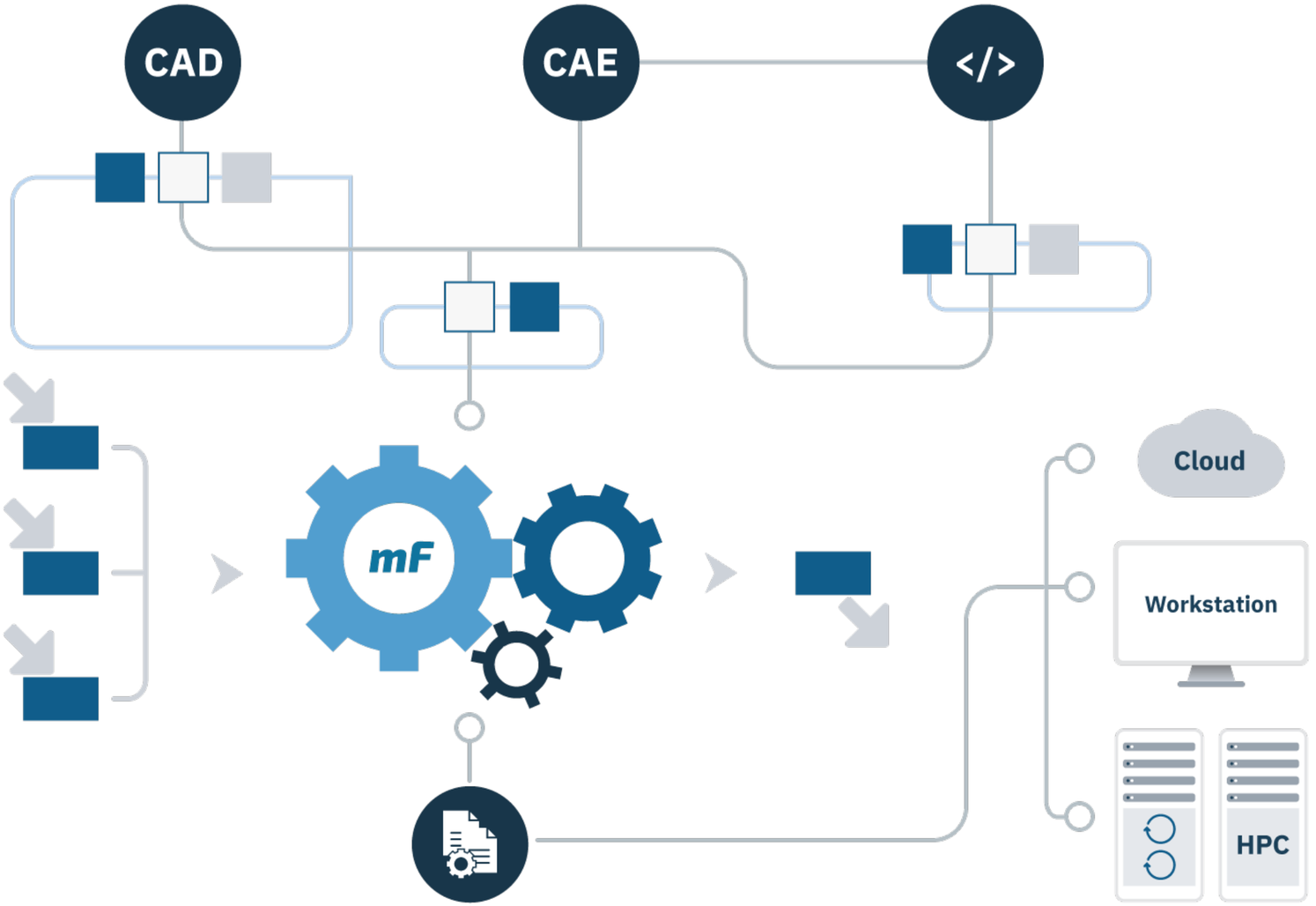
Design space understanding

Optimization-driven design

Robust and uncertainty quantification

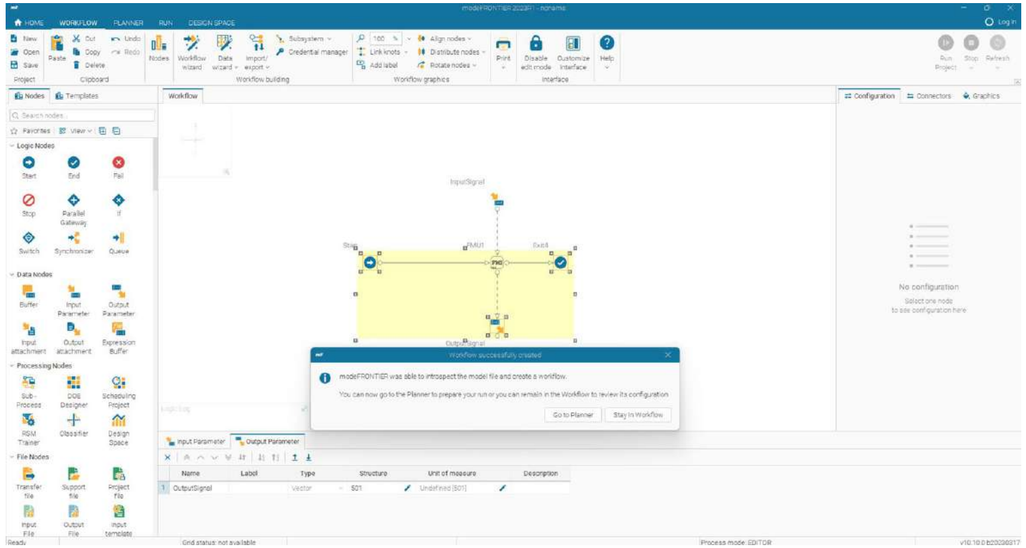
Post-processing and decision making tools

modeFRONTIER – operating principle



Guided Process

- Provides a fast gateway for your model to be optimized in modeFRONTIER.
- Drag and drop your model file to the workflow canvas. modeFRONTIER will extract all the parameters and responses from it. Then you can skip the workflow and go directly to the Planner to start the optimization.



modeFRONTIER 2023R1 - ReleaseCandidate3 - RC3 - noname

Log in

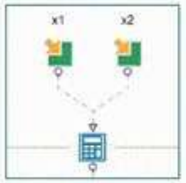
- Home
- New
- Open
- Save
- Save As
- Tools
- Options
- Info
- Help
- Exit

Start from template

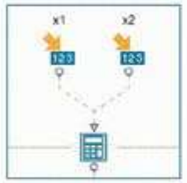
My template folder

System templates

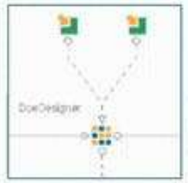
Buffer



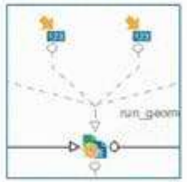
Calculator

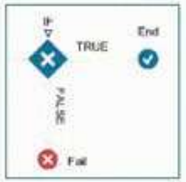


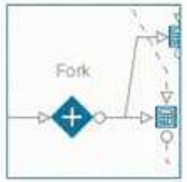
Calculator with Plan

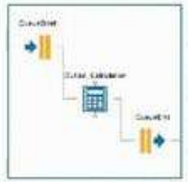


DOE Designer





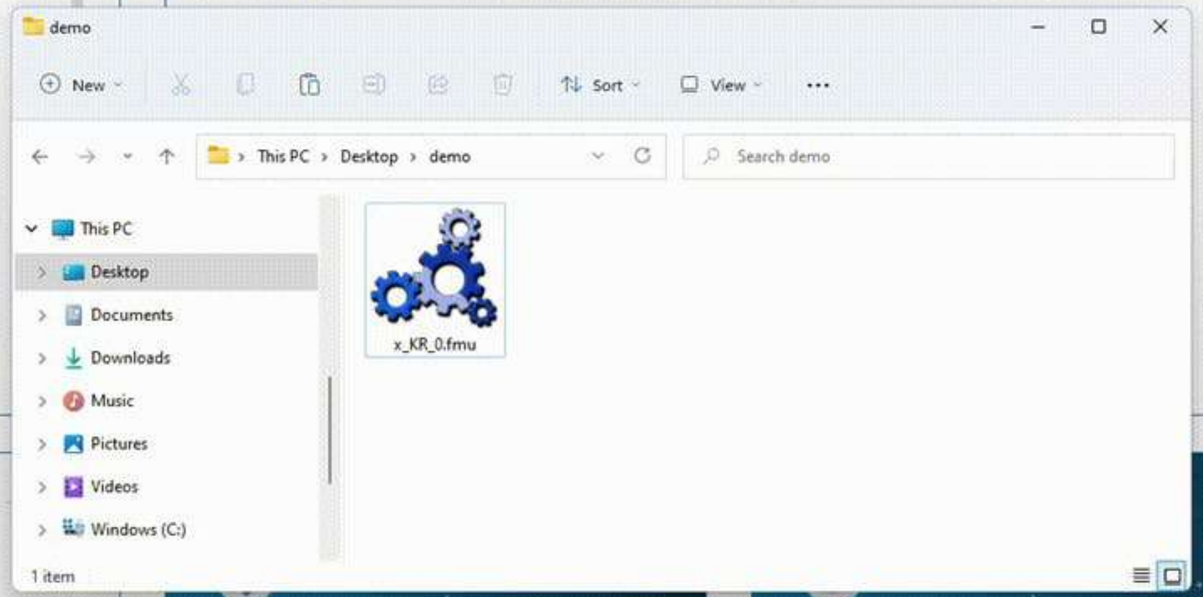




Projects

Pinned projects

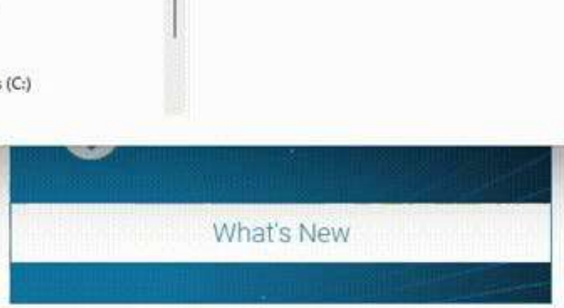
Recent projects

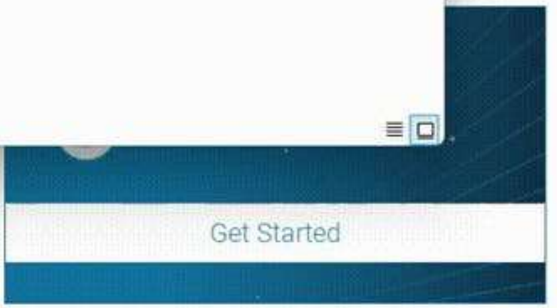


Drag & Drop

a model file or browse to create a complete workflow

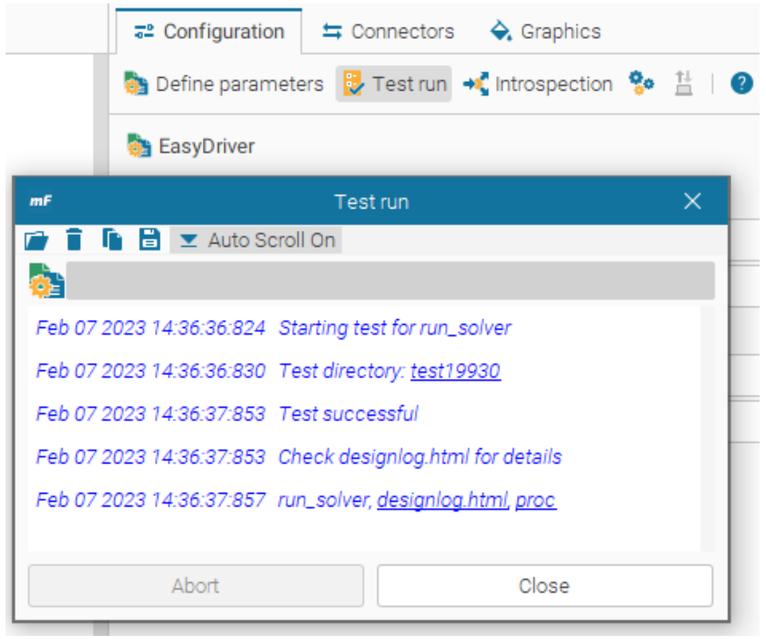
Browse





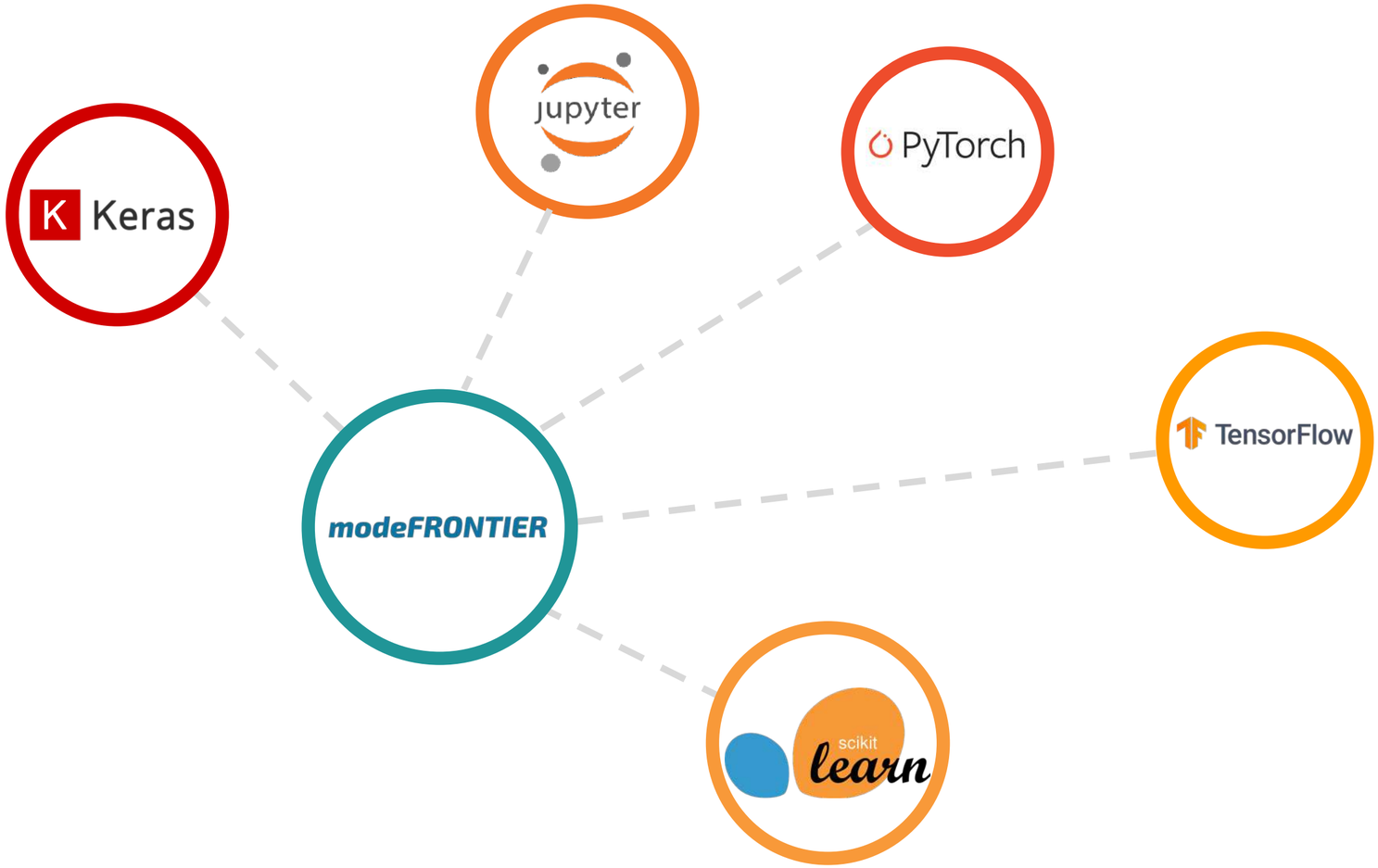
Easydriver Test Run

- Save time by debugging your integration without running the entire modeFRONTIER workflow.
- You can reproduce the actual runtime environment of your integration and check that everything is right with variables and files in your driver.
- Available in the Easydriver node configuration toolbar.



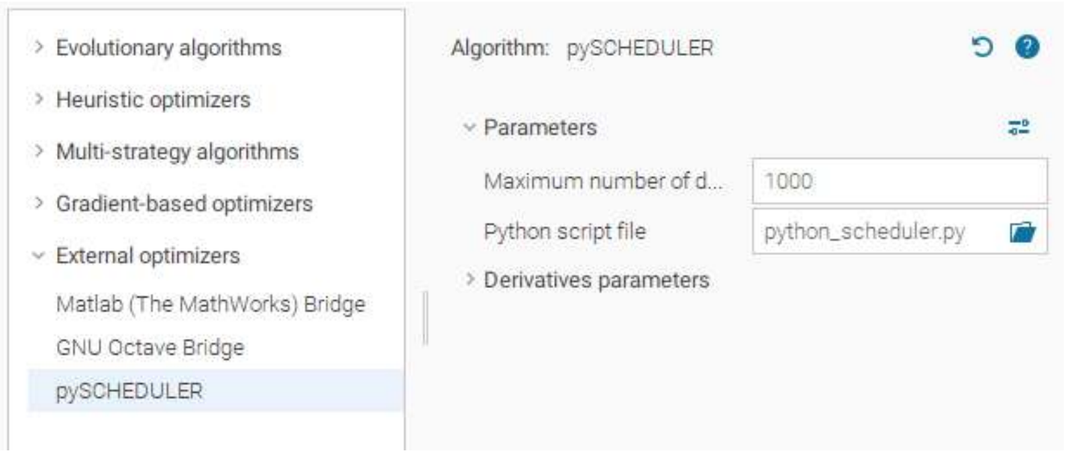
Python eco-system in modeFRONTIER

pyCONSOLE
CPython node
pyRSM
pySCHEDULER
pyDOE
pyFRONTIER



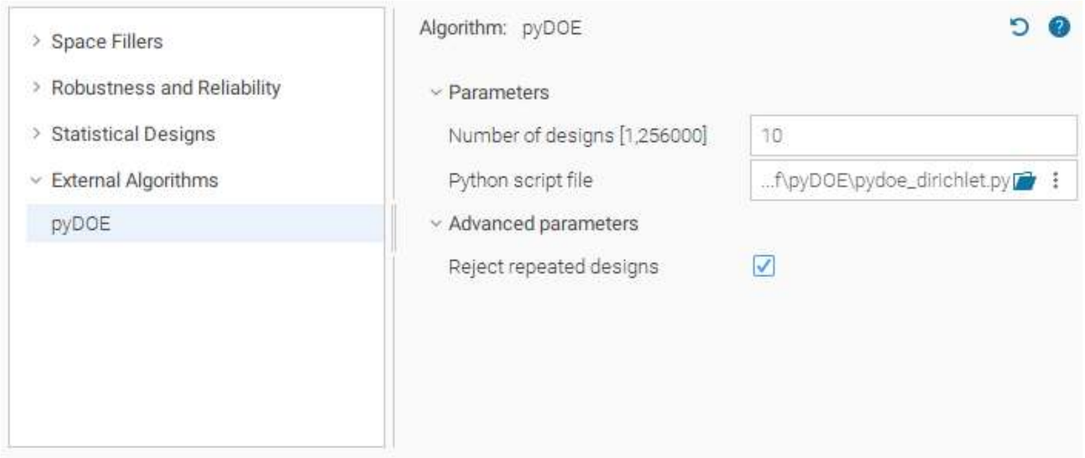
pySCHEDULER

- You can drive your design space exploration sessions in modeFRONTIER with python scripts.
- A set of internal python APIs allows you to link your optimization algorithm or built-in python algorithms to the modeFRONTIER evaluation engine.
- Available both in the Scheduling mode and the Process mode.

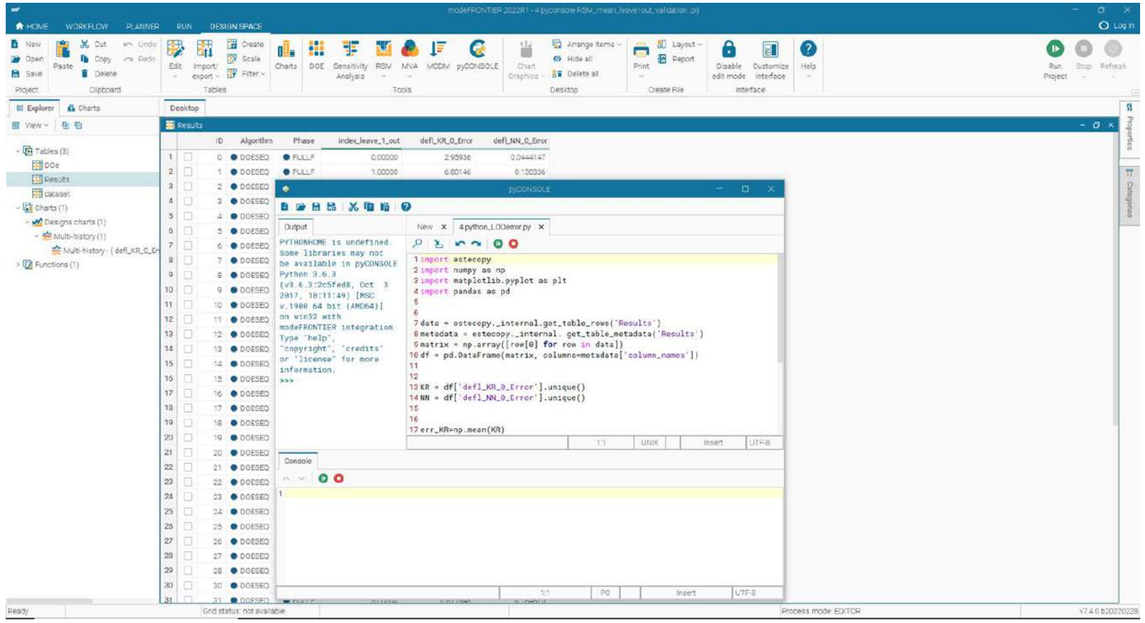


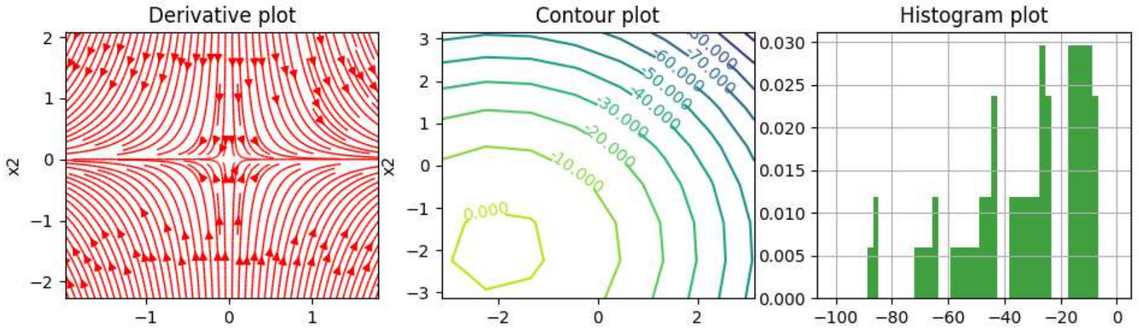
pyDOE - Python bridge for Design of Experiments

- You can drive your design space exploration sessions in modeFRONTIER with python scripts.
- A set of internal python APIs allows you to link your exploration algorithm or built-in python algorithms to the modeFRONTIER evaluation engine.
- Available both in the Scheduling mode and the Process mode.



pyCONSOLE





This Python-based console allows to apply customized Python script to automate the analysis and perform advanced postprocessing

pyRSM – Train and evaluate

mF File Edit Options View Expression Editor

```
1 import numpy as np
2 from sklearn.gaussian_process import GaussianProcessRegressor
3 from sklearn.gaussian_process.kernels import DotProduct, WhiteKernel
4
5 def train(inputs_values, output_values, input_names, output_name):
6     X = np.array(inputs_values)
7     y = np.array(output_values)
8     kernel = DotProduct() + WhiteKernel()
9     return GaussianProcessRegressor(kernel=kernel,random_state=0).fit(X, y)
10
11 def evaluate(gpr, input_data):
12     predTest = np.array(input_data)
13     gprPred,stdPred=gpr.predict(predTest.reshape(3,-1), return_std=True)
14     return gprPred
```

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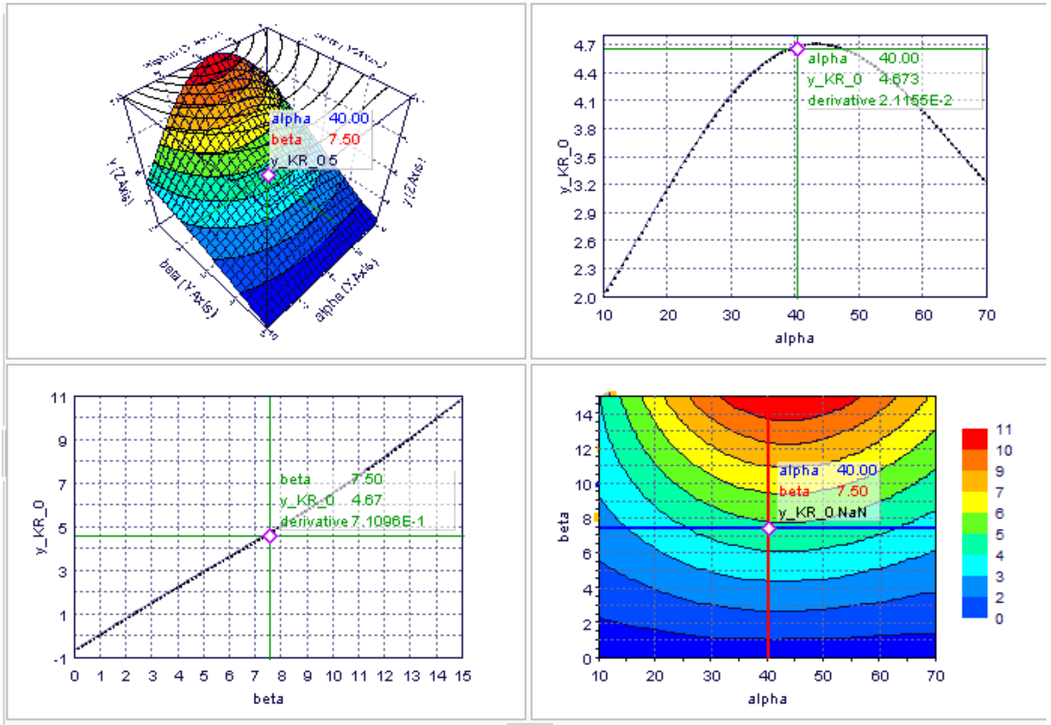
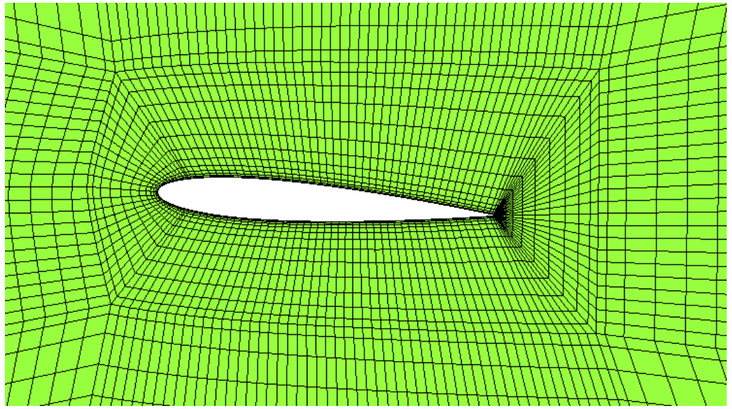
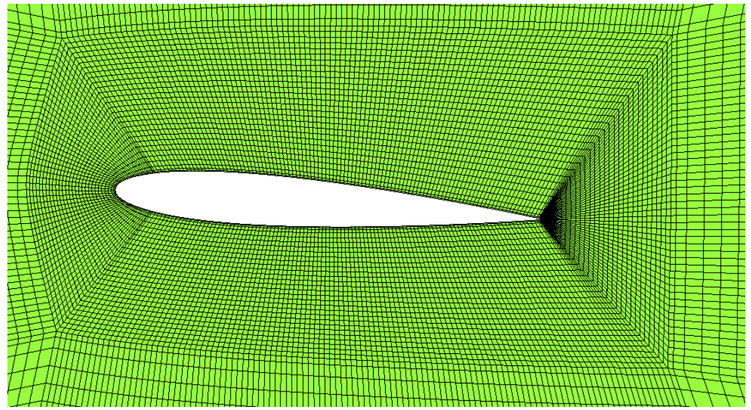
OK Cancel



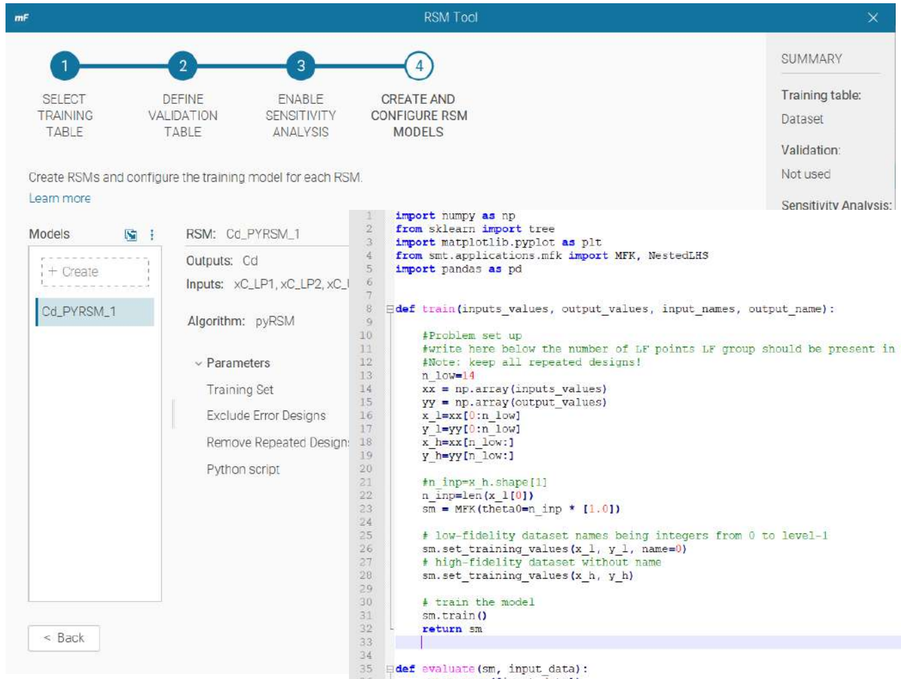
Training and evaluation features
as modeFRONTIER native RSMs

pyRSM: Multi-fidelity RSM (Cokriging)





- Low fidelity: 30,000 elements (50 samples)
- High fidelity: 150,000 elements (10 samples)



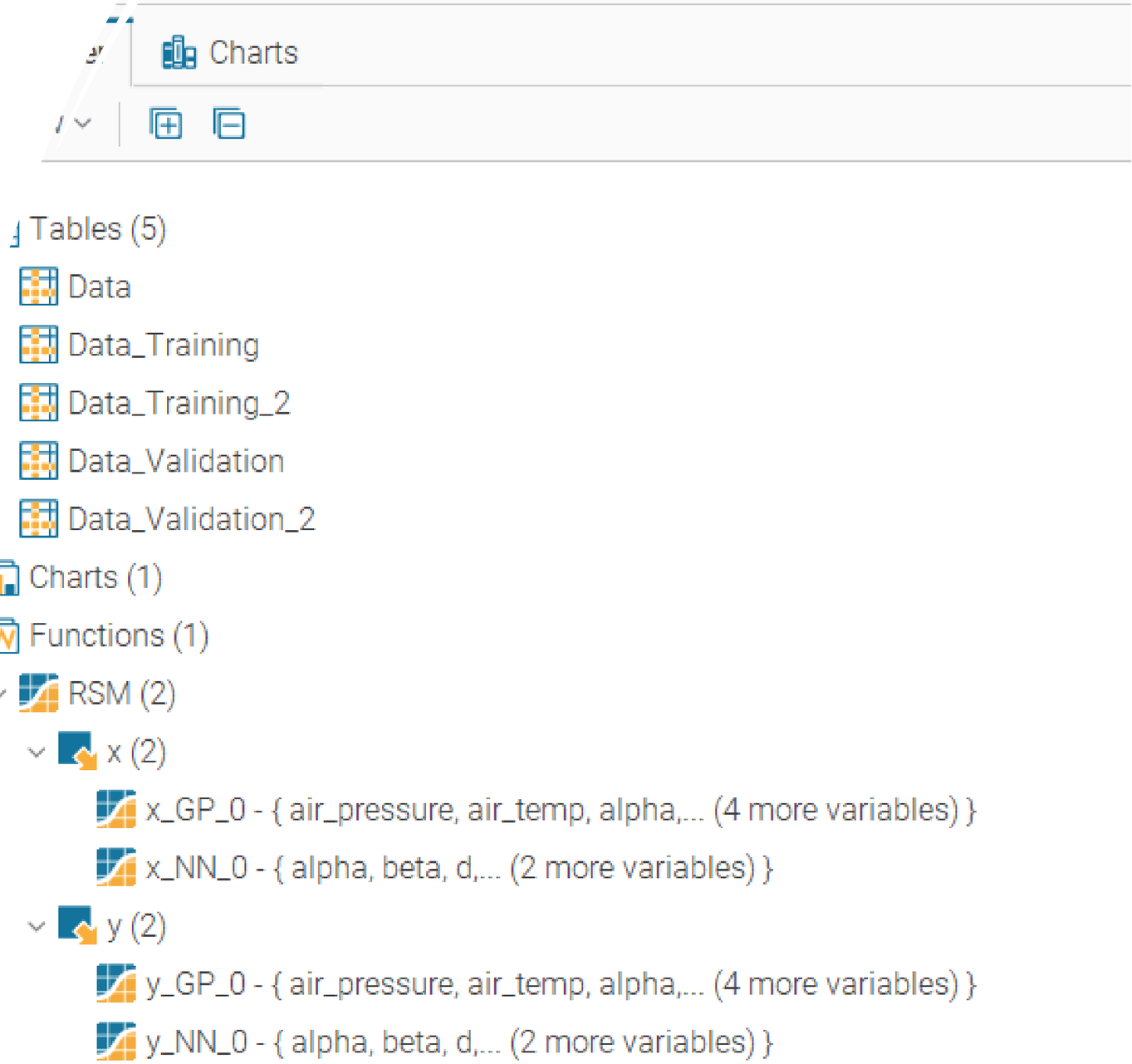

```python
import numpy as np
from sklearn import tree
import matplotlib.pyplot as plt
from smt.applications.mfk import MFK, NestedLHS
import pandas as pd

def train(inputs_values, output_values, input_names, output_name):

    #Problem set up
    #write here below the number of LF points LF group should be present in the Training table before the HF group.
    #Note: keep all repeated designs!
    n_low=14
    xx = np.array(inputs_values)
    yy = np.array(output_values)
    x_l=xx[0:n_low]
    y_l=yy[0:n_low]
    x_h=xx[n_low:]
    y_h=yy[n_low:]

    #n_inp=x_h.shape[1]
    n_inp=len(x_l[0])
    sm = MFK(theta0=n_inp * [1.0])

    # low-fidelity dataset names being integers from 0 to level-1
    sm.set_training_values(x_l, y_l, name=0)
    # high-fidelity dataset without name
    sm.set_training_values(x_h, y_h)

    # train the model
    sm.train()
    return sm

def evaluate(sm, input_data):
    x=np.array([input_data])
    y=sm.predict_values(x)
    #mse = sm.predict_variances(x)
    #derivs = sm.predict_derivatives(x, kx=0)
    return y
```

RSM comparison

Output	Name	Mean absolute error	Mean relative error	Mean normalized error	R-squared	AIC
Cd	Kriging_Random	3.86E-5	3.38E-3	7.19E-2	8.81E-1	-1.74E2
Cd	Kriging_DatasetReducer	2.57E-5	2.25E-3	4.79E-2	9.48E-1	-1.80E2
Cd	Cokriging_DatasetReducer	2.62E-5	2.28E-3	4.88E-2	9.61E-1	-2.09E2

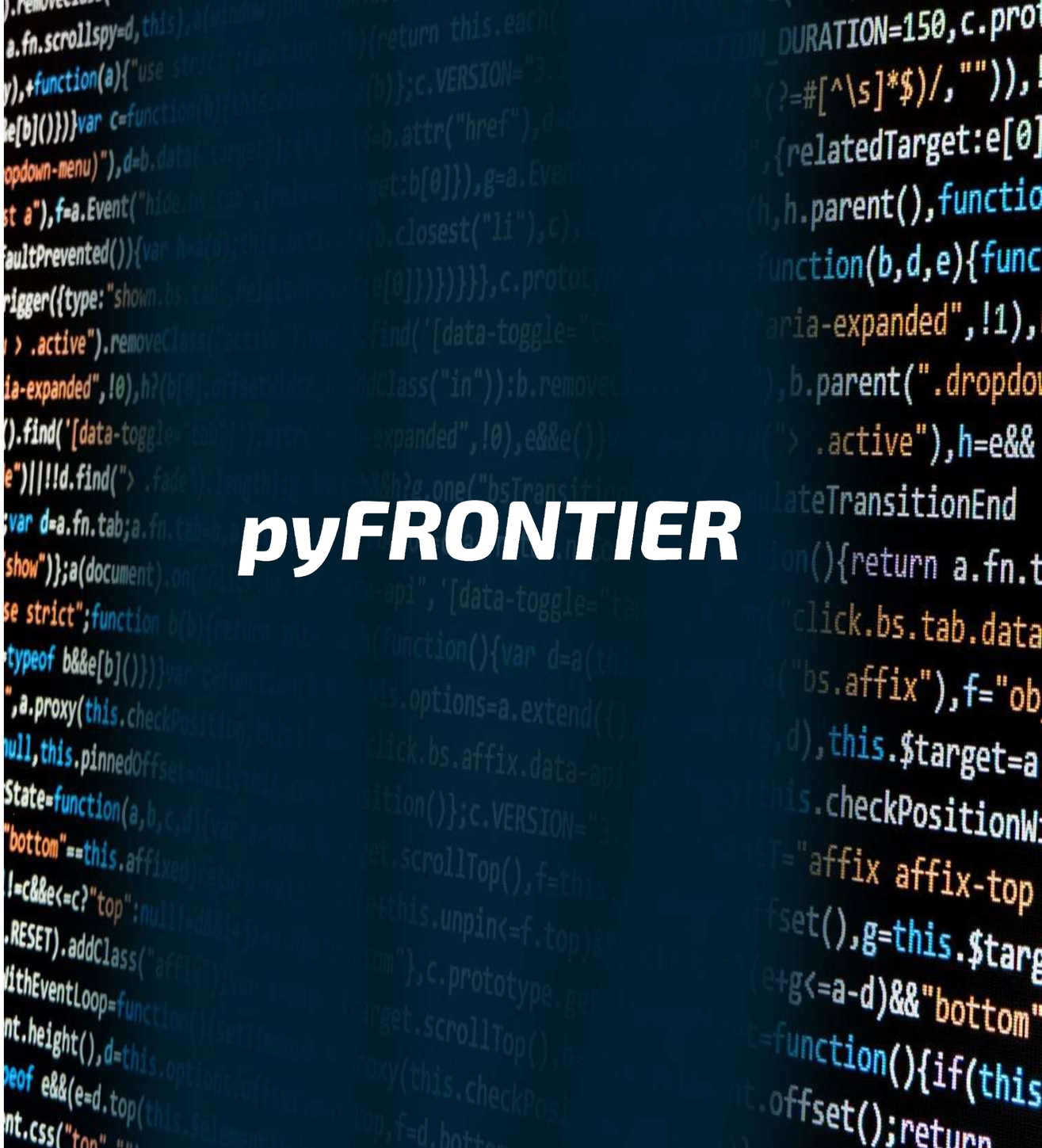
pyRSM: importing and combining different RSMs

- Simultaneously evaluate many RSMs on the same point. Collect predicted values and associated standard deviations and choose the best RSM.



Exchange data and functions *interactively* between external Python environments and modeFRONTIER with a set of dedicated APIs

- Code in your preferred Python IDE and drive modeFRONTIER from there
- Deploy modeFRONTIER design space datasets and functions directly into your solver
- Configure modeFRONTIER plans and start batch evaluations (not yet implemented)



Simulation operational challenges

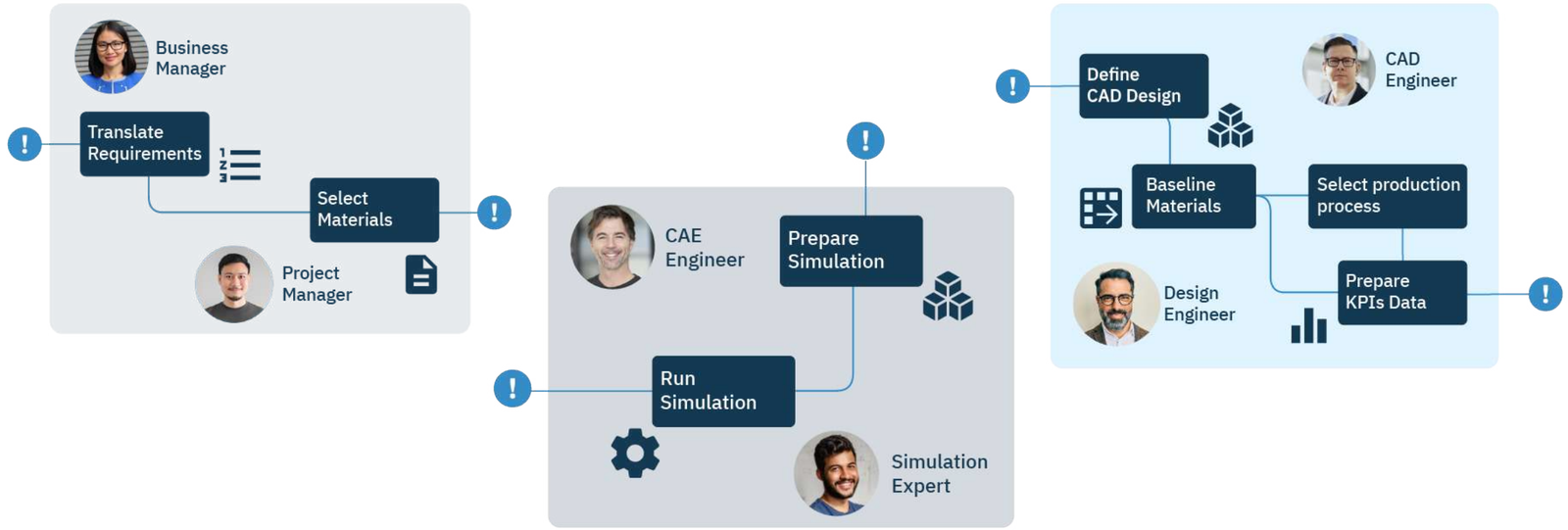
Connect simulation data to product digital thread

Version management and traceability of simulation data

Enable non-simulation experts to perform routine analysis

Deliver ready-to-use CAE workflows

Teams work in silos



- Inefficient collaboration between departments
- Undefined engineering design processes
- Fragmented access to lots of vendor-locked tools
- Access to simulation data is limited to domain experts

Adopting SPDM solutions, but...

Capabilities

Low levels of CAE workflow automation and design optimization.

Embedded SPDM in PLM ecosystems takes time and customization efforts.

People

Encourage use of a common SPDM platform instead of in-house solutions.

Maintain adoption levels.

Company culture

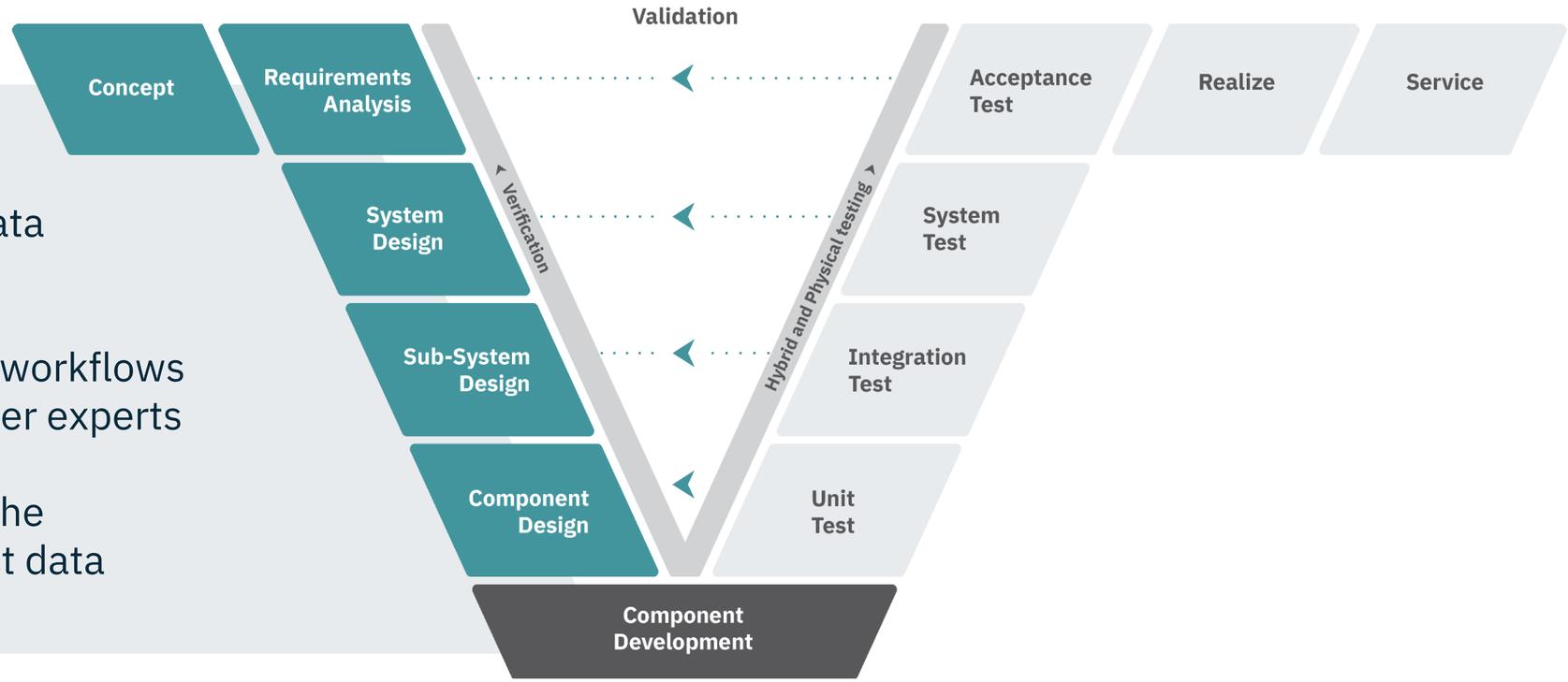
SPDM ROI takes resources, effort and time. Management must be on board.

Mindset needs to change: *“We have always done it this way”.*

Imagine a digital engineering solution that...

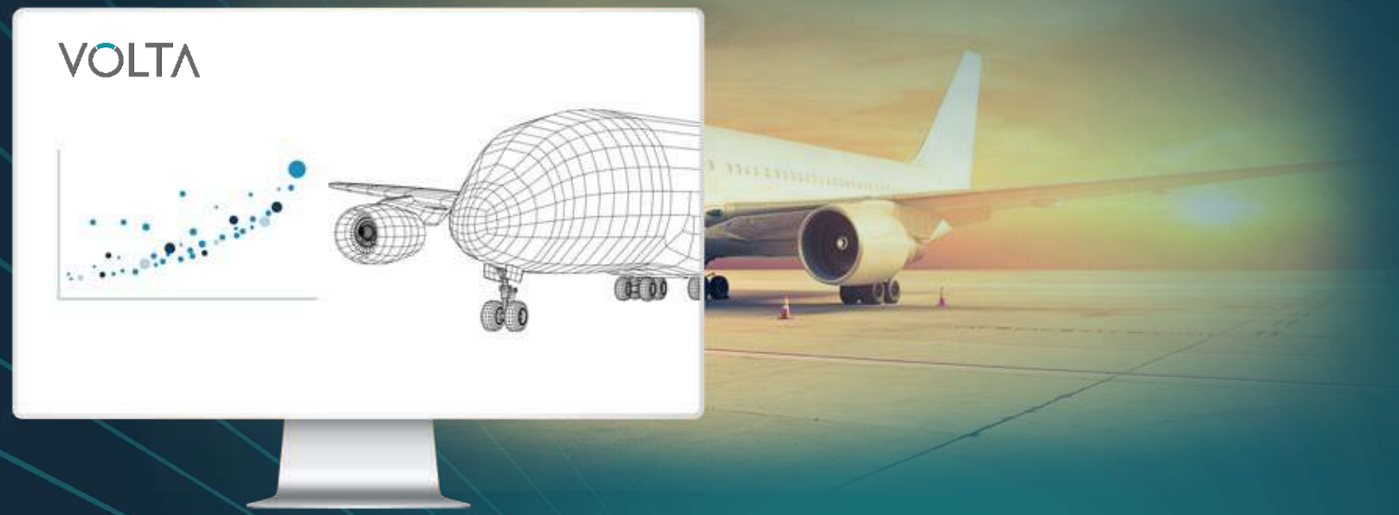
Improves model-based design processes for Multidisciplinary Design Optimization (MDO).

- Exchange simulation data across teams
- Share automated MDO workflows with other subject matter experts
- Connect simulation to the digital thread of product data



ESTECO VOLTA

The digital engineering platform for SPDM and Design Optimization.



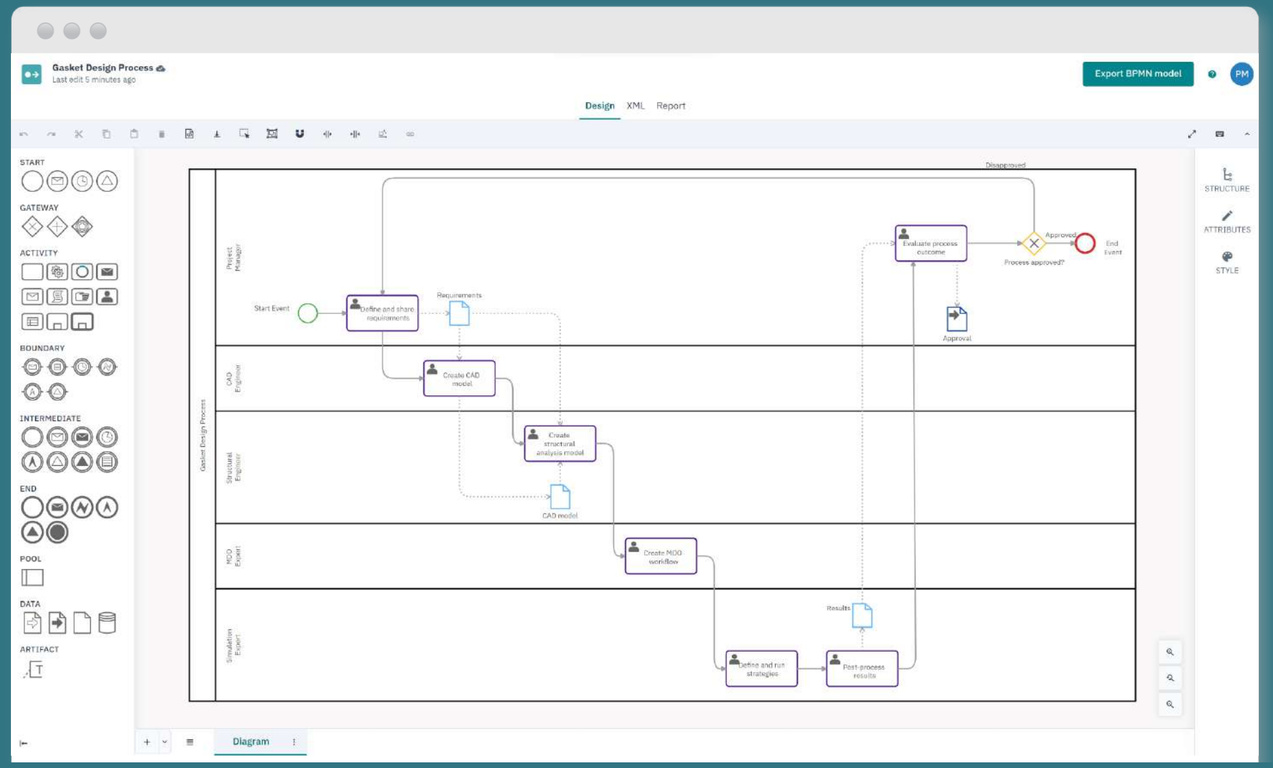
Take full control over the engineering design process, from simulation workflows to high-level business decisions.

What VOLTA can do for your organization

Web-based collaborative platform designed for simulation-driven product development.

VOLTA Modeler

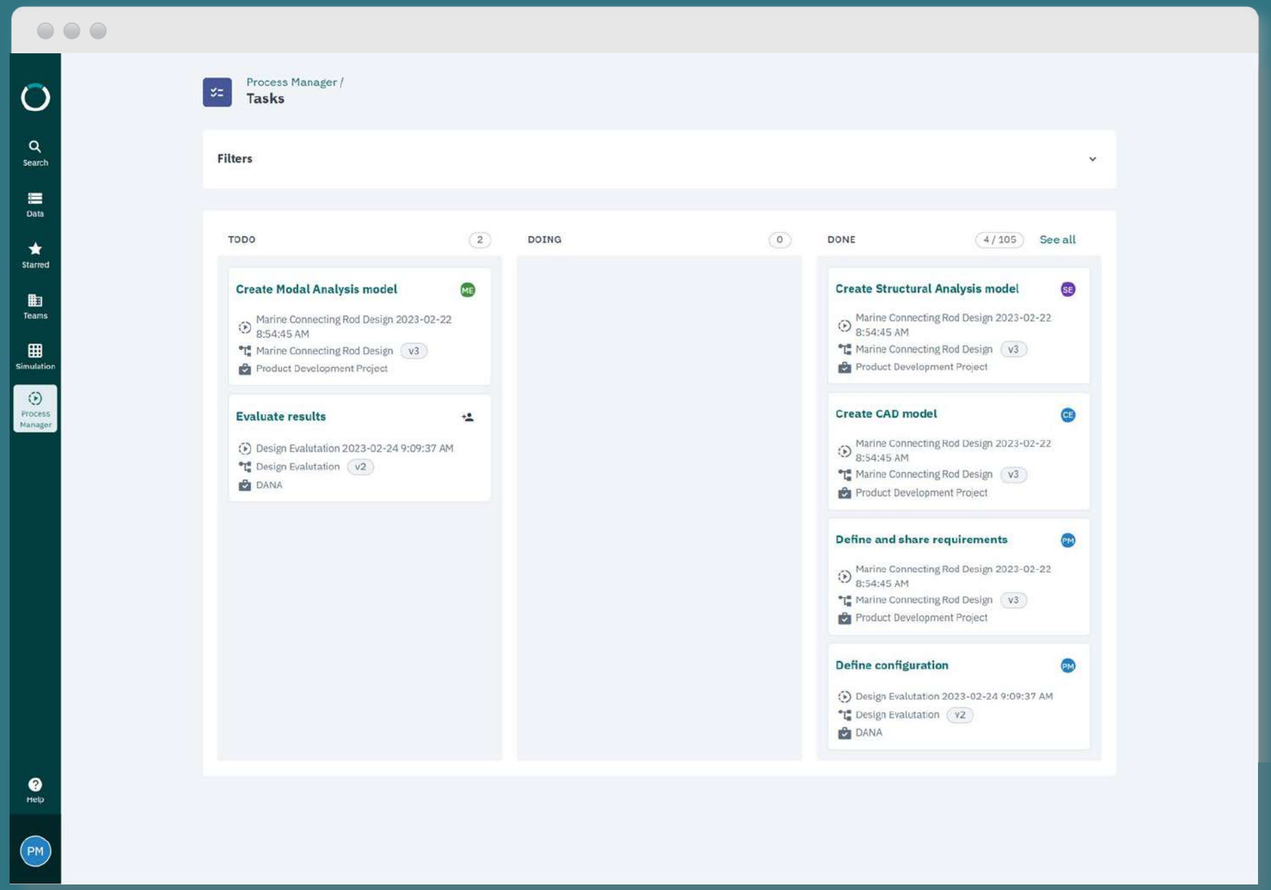
Map and standardize engineering design processes.



- Map with BPMN 2.0 workflows to formalize existing practices into documented processes
- Manage people interactions and integrate tasks in executable business processes
- VOLTA Service task: integrate simulation workflows and perform design space exploration studies

VOLTA Process Manager

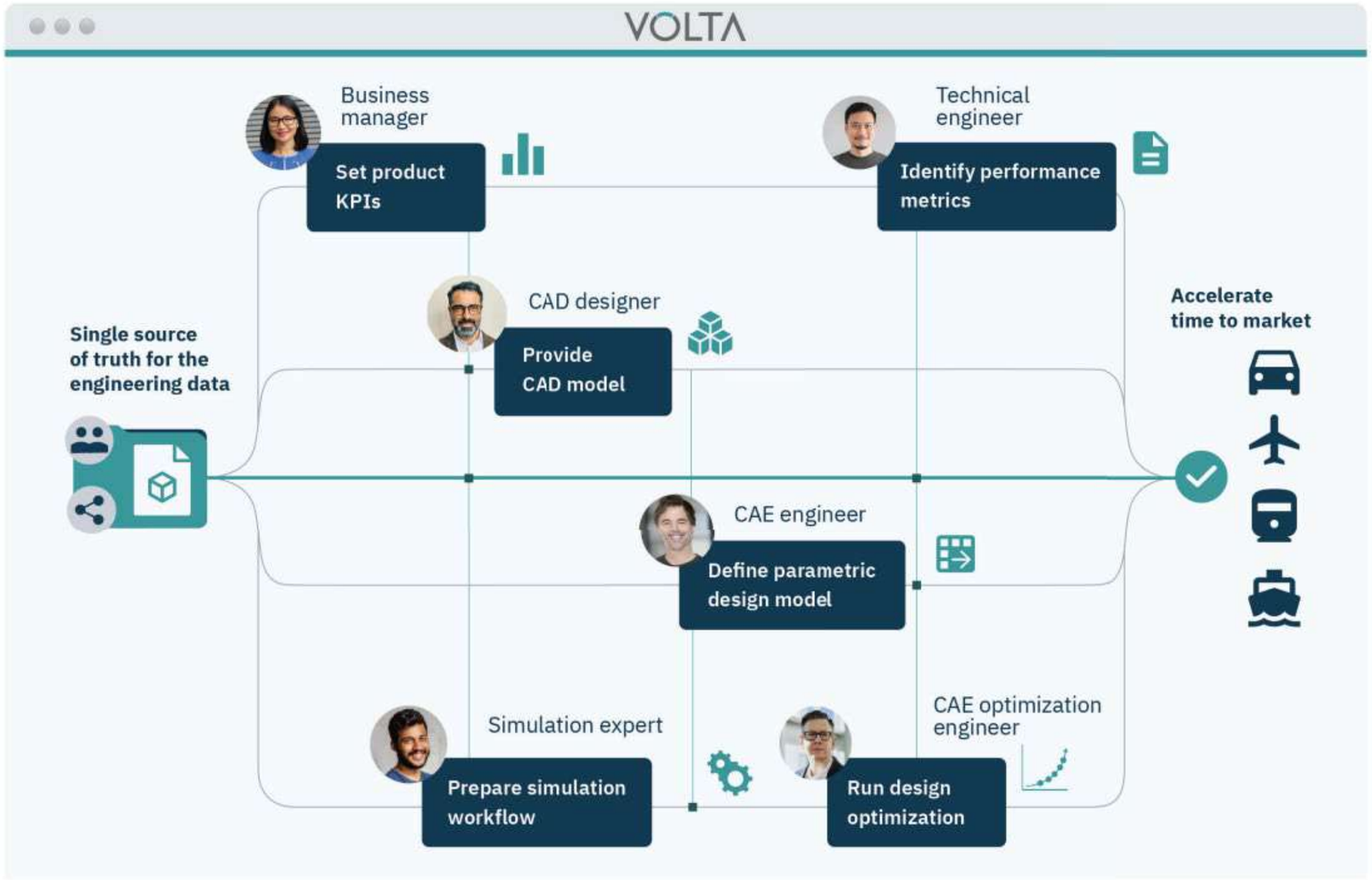
Execute engineering design processes.



- Run processes created in the VOLTA Modeler environment
- Manage process sequence and deliver tasks to the right resource at the right time using a Kanban board
- Ensure full traceability to keep track of every action performed during execution

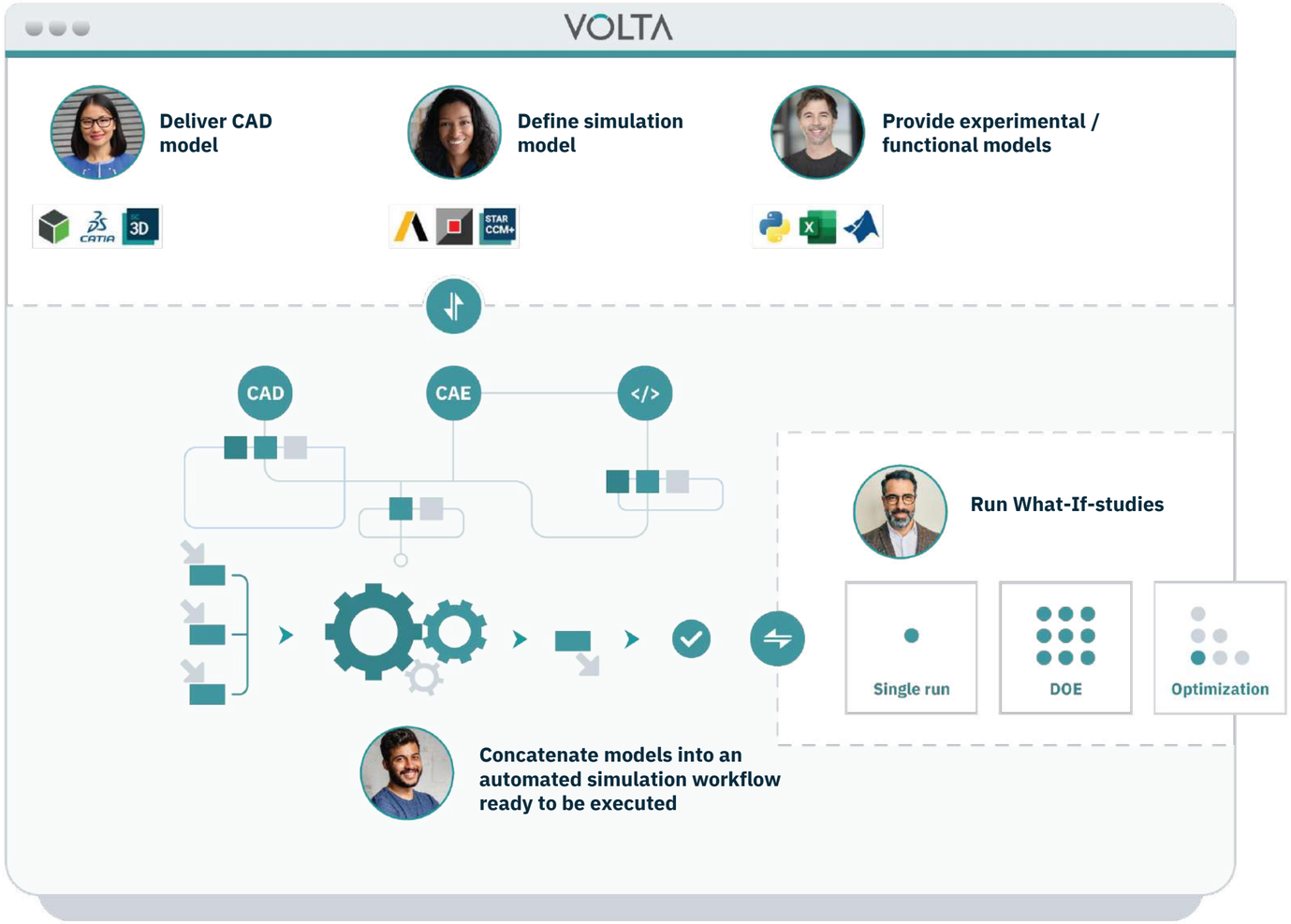
Maximize the enterprise-wide flow of data

Information flows across teams, reaching the right people at the right time.



Democratize multidisciplinary simulations

Streamline expert simulation work and deliver automated workflows re-usable by a wider audience of engineers.

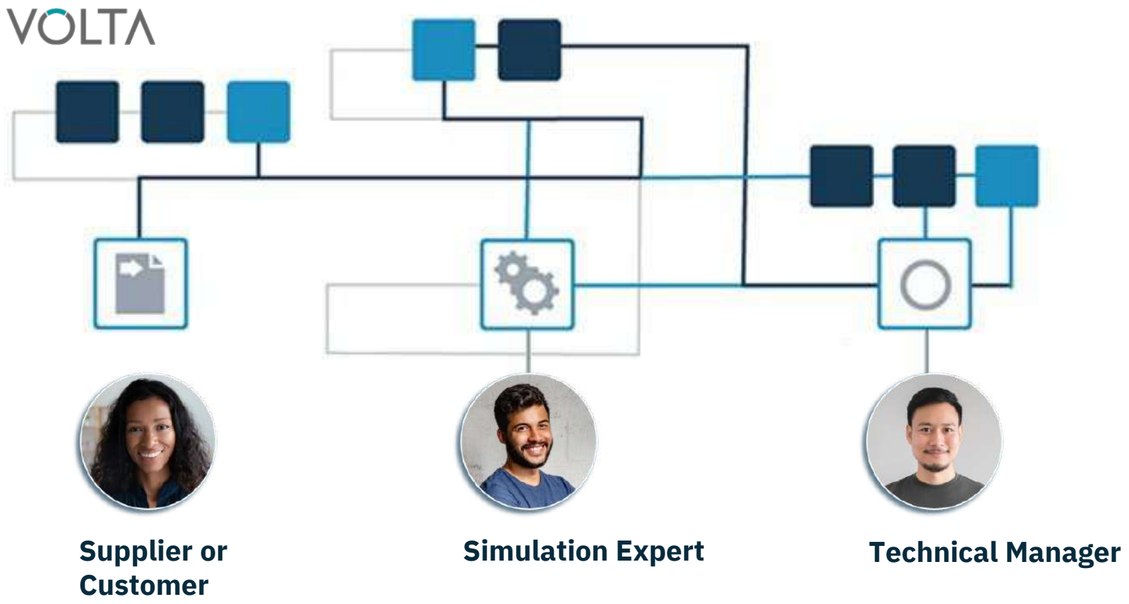


Extend simulation in B2B or B2C context

Enabling OEMs, suppliers and customers to collaborate with each other in real time

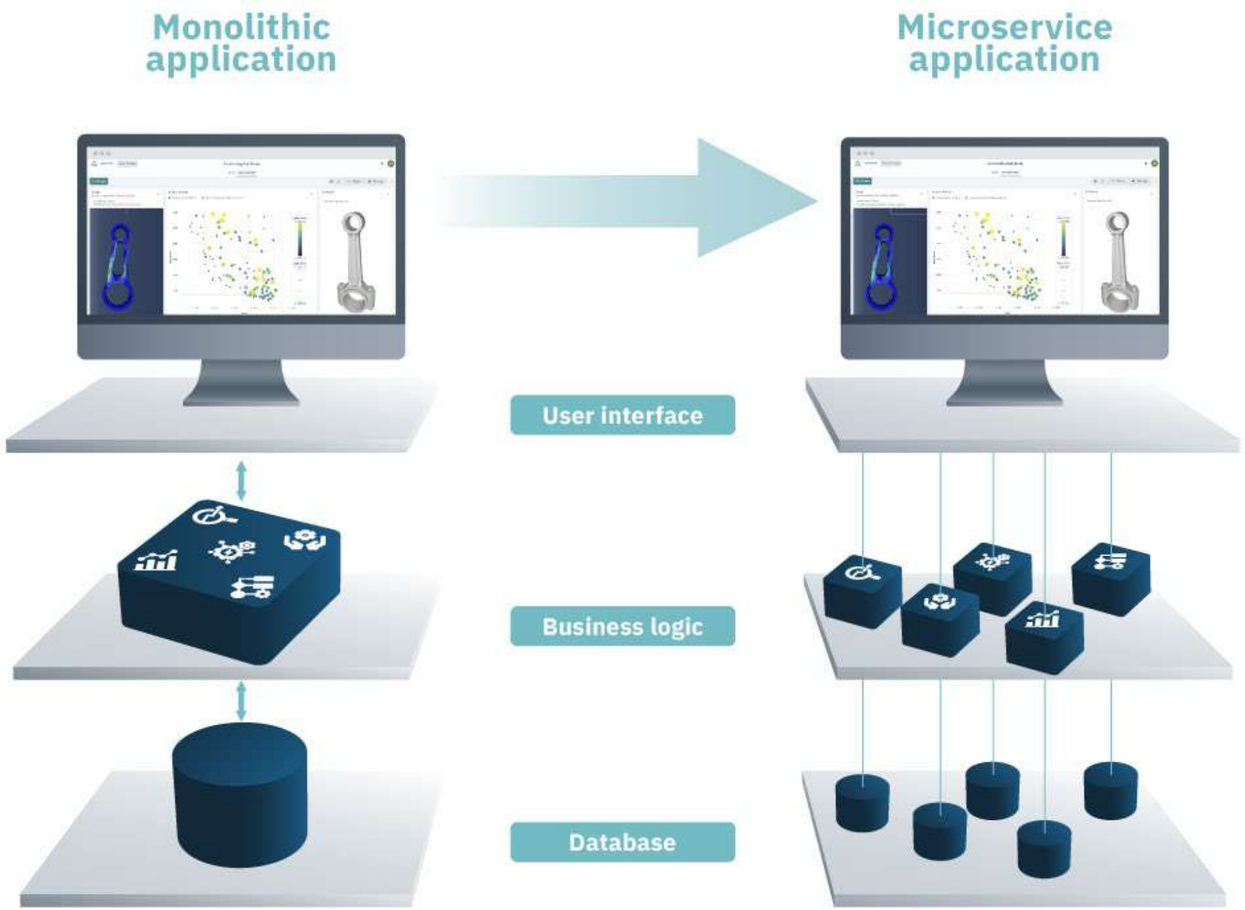
In this scenario, a supplier or customer can:

- Connect to VOLTA and share their simulation models
- Modify, version or update simulation models directly in VOLTA
- Provide the latest simulation model which is automatically used in the MDAO workflow



Redesigned VOLTA architecture

Standalone and Cloud Deployment Options



VOLTA Player

Monitor and manage local and remote computing resources to run complex simulations.

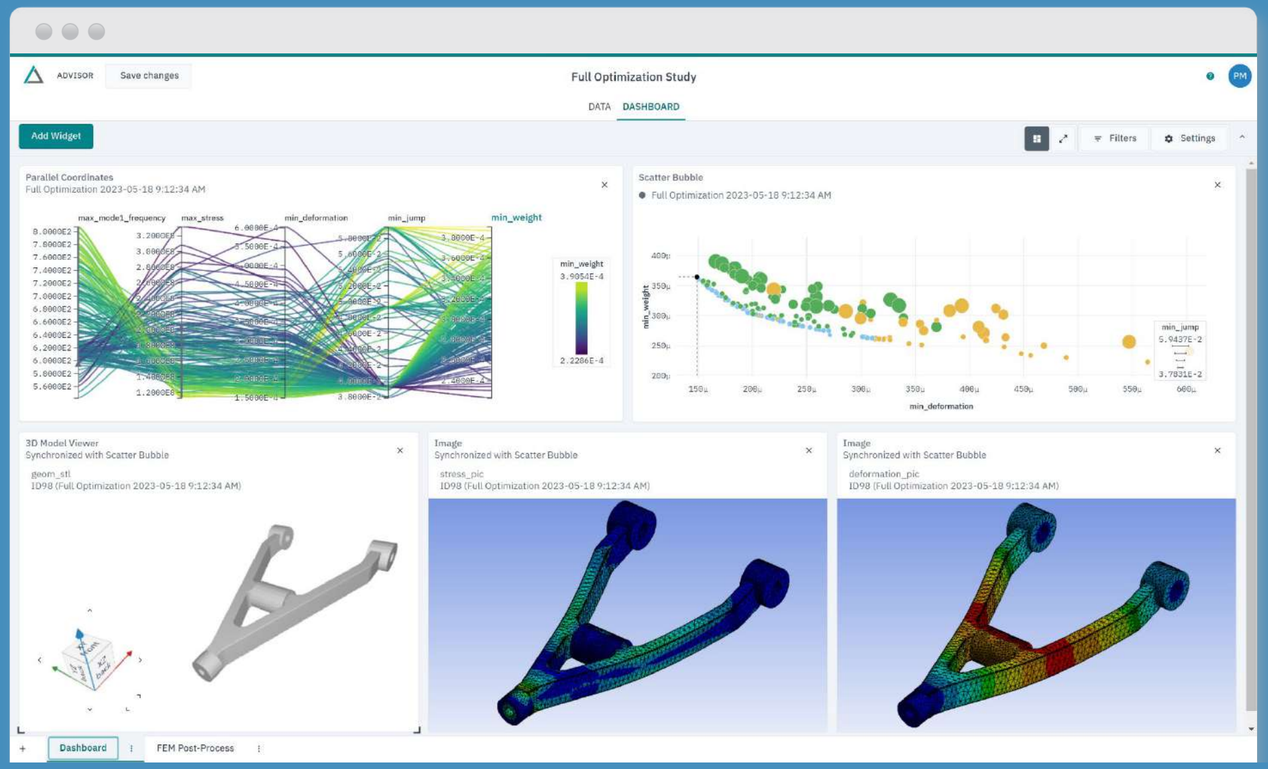
Smart use of computing resources to reduce lead time

Execute simulations in parallel on ICT infrastructures

Exploit multi-core workstations, HPC clusters and public clouds

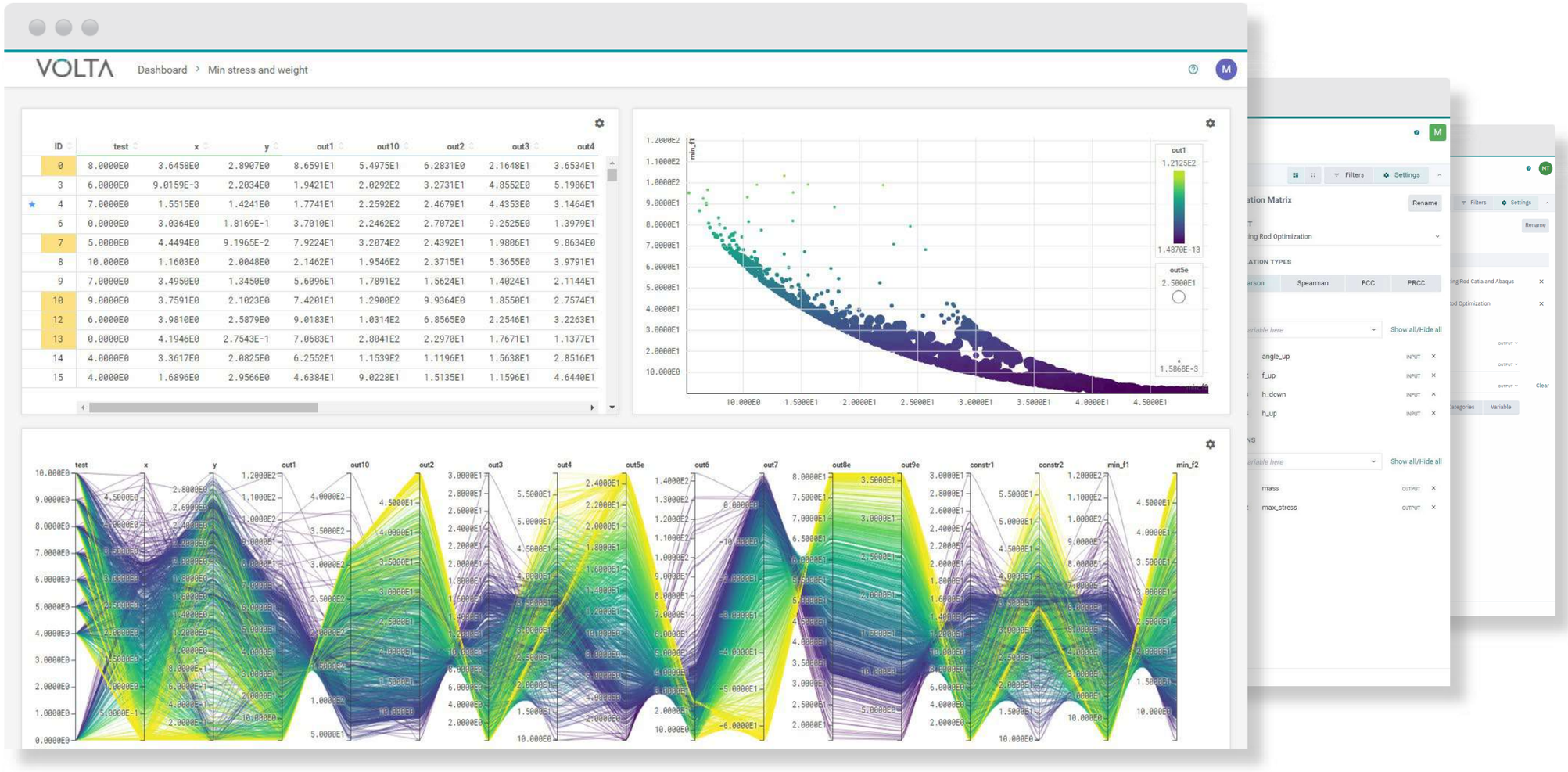
VOLTA Advisor

Create post-processing dashboards for analyzing design space exploration studies.

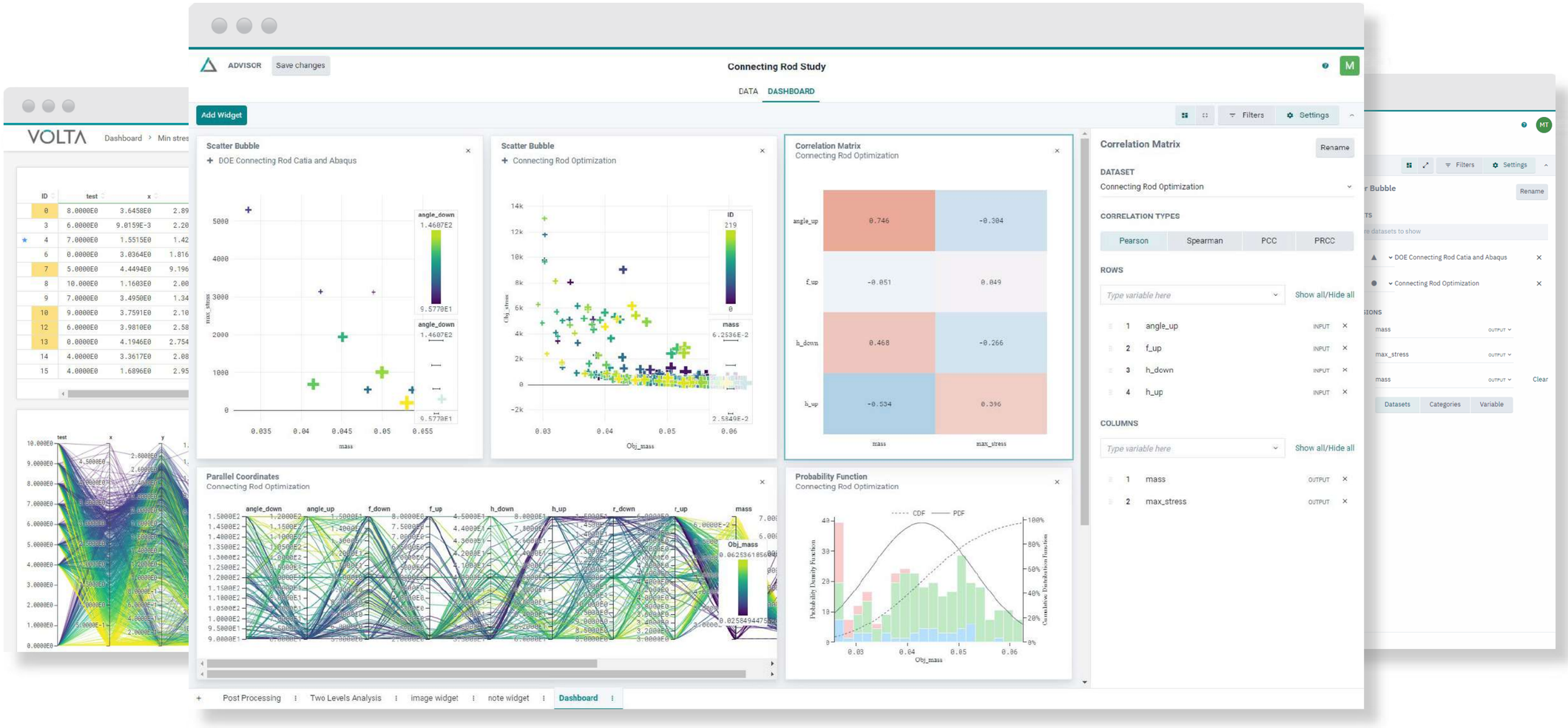


- Interpret simulation data with a wide array of advanced data analysis tools and web-based interactive charts
- Enable multiple stakeholders to predict product behavior and share insights
- Access simulation results and change request in real time

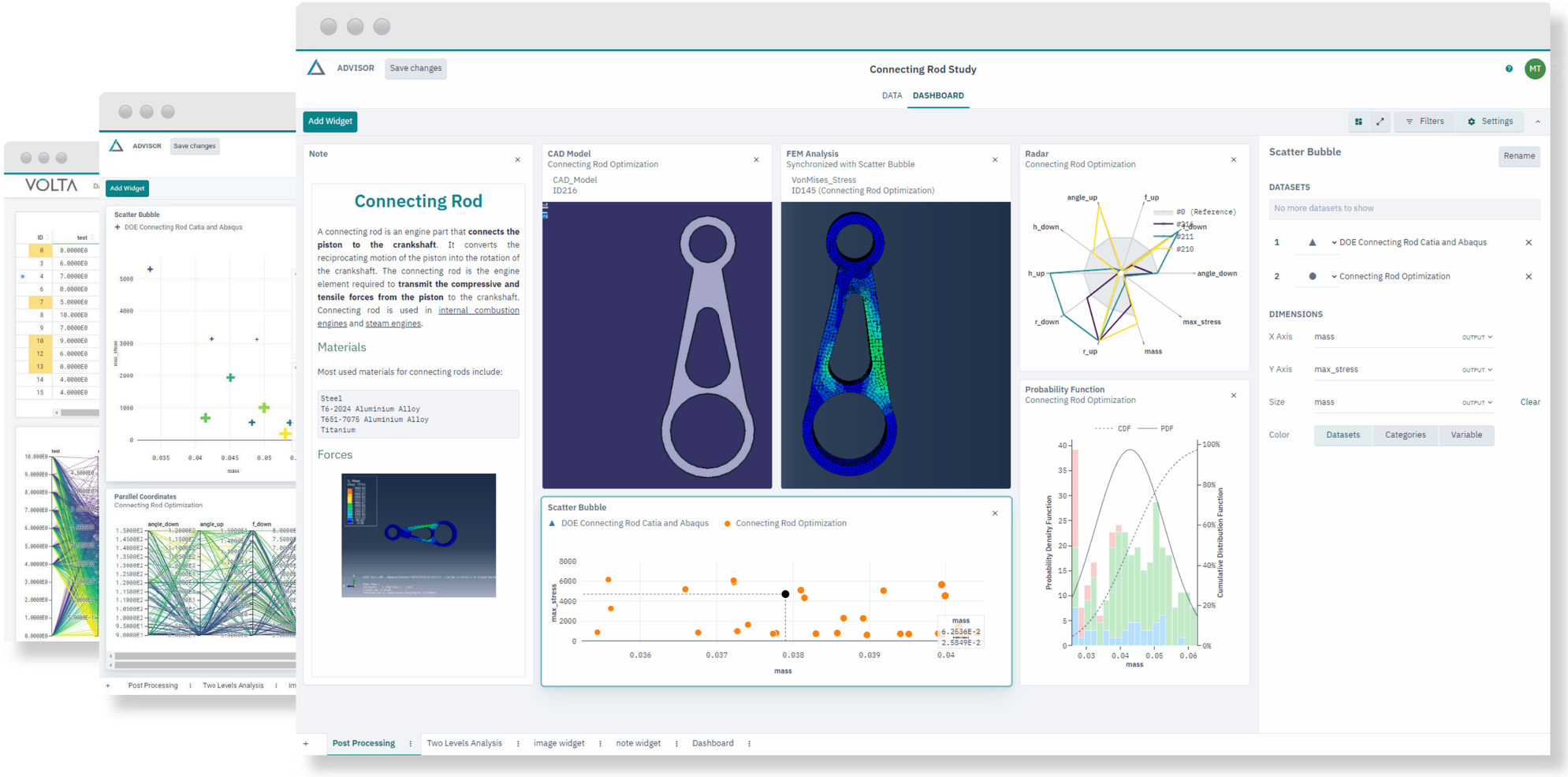
Charts, Images and 3D Viewers



Charts, Images and 3D Viewers

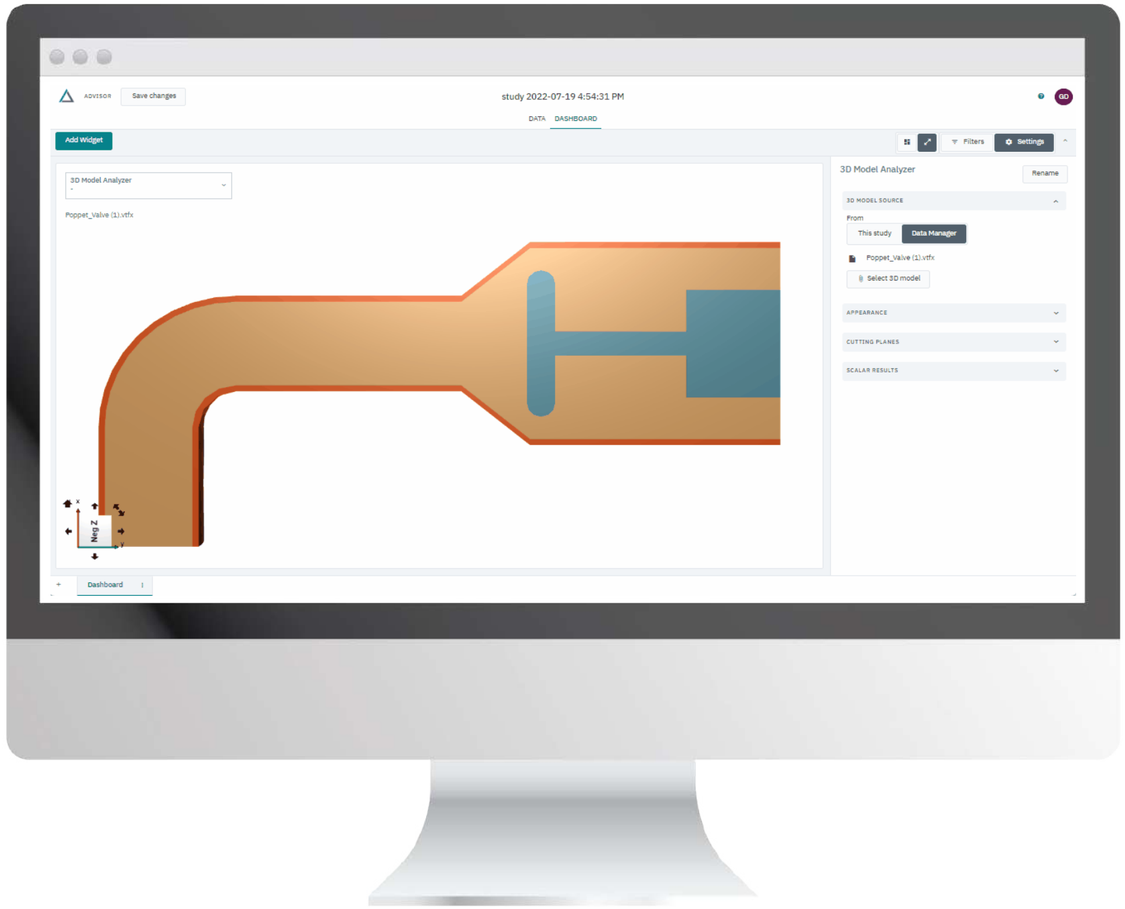


Charts, Images and 3D Viewers



Seamless 3D CAE visualization

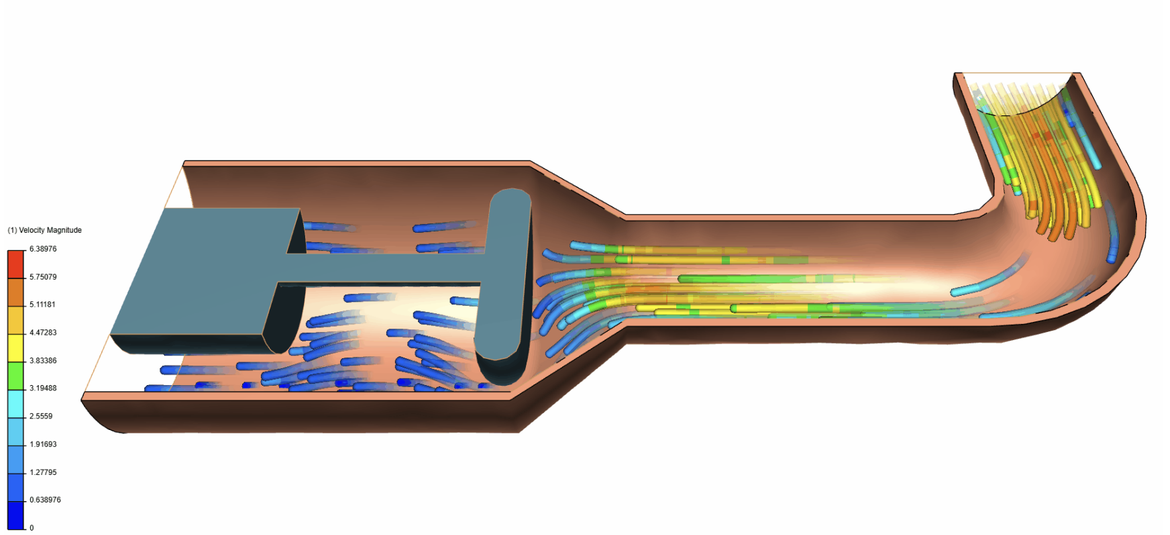
Post-process CAD/CAE models from a web dashboard and share the insights in real-time with other stakeholders.

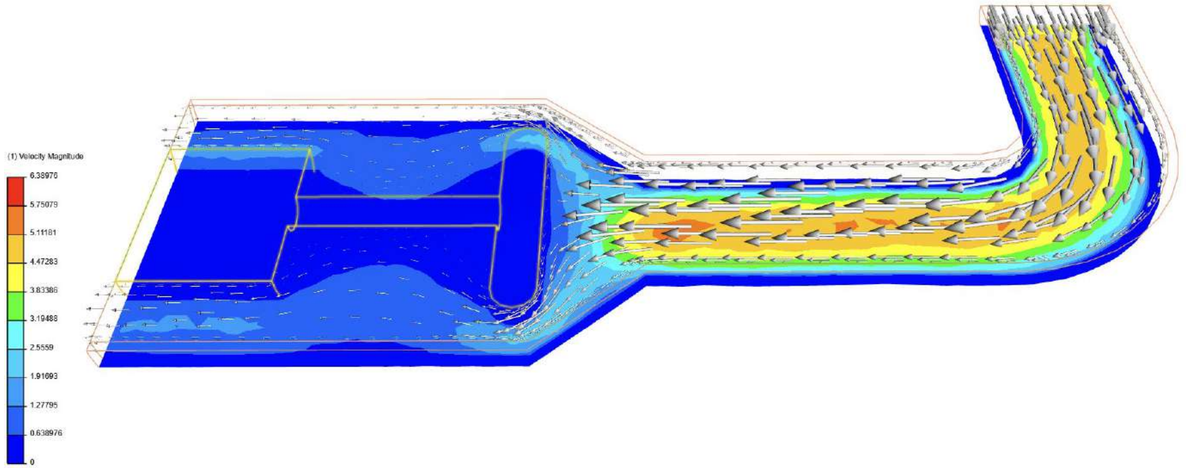


3D Model Analyzer

Post-Processing for:

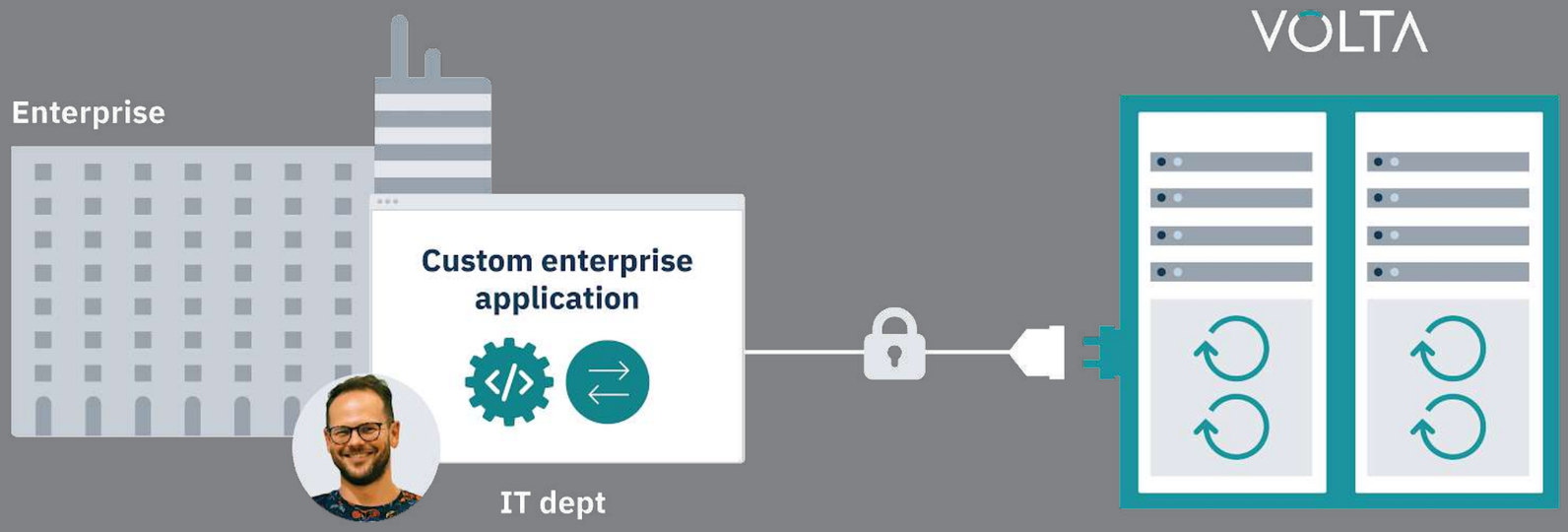
- Structural CAE
  - Scalar results
  - Deformations
  - Animations
- Computational Fluid Dynamics
  - Vector results
  - Ribbons and particles
  - Animations





Interoperability with other enterprise systems

VOLTA APIs guarantees digital continuity: integration with PLM systems and company’s digital thread.



VOLTA API: verticalizations enabler

No IP-sharing requirements for customer’s custom-built extensions

Stable

REST, JSON format for request, response bodies and errors

Documented

Documentation with changelog

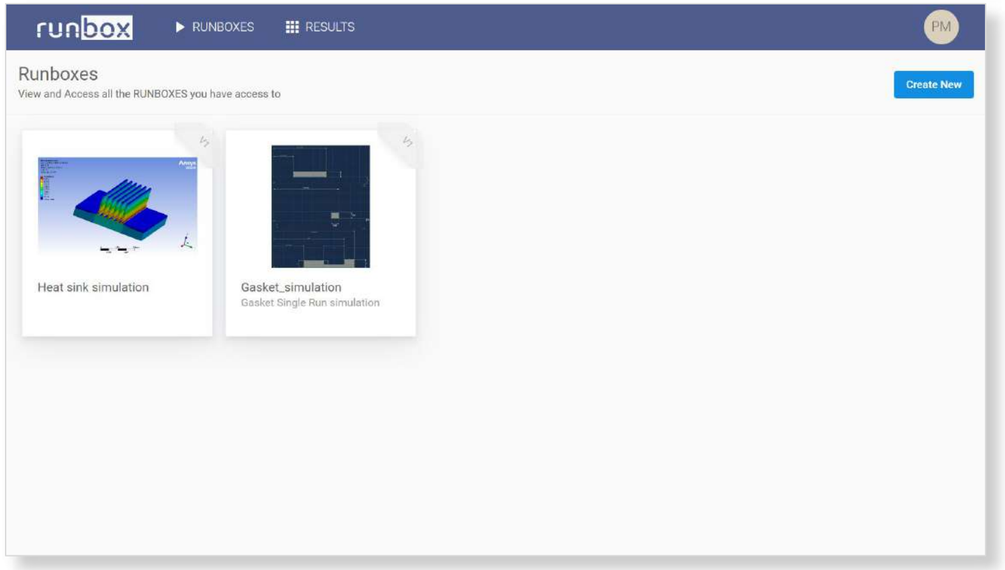
Maintained

At least for

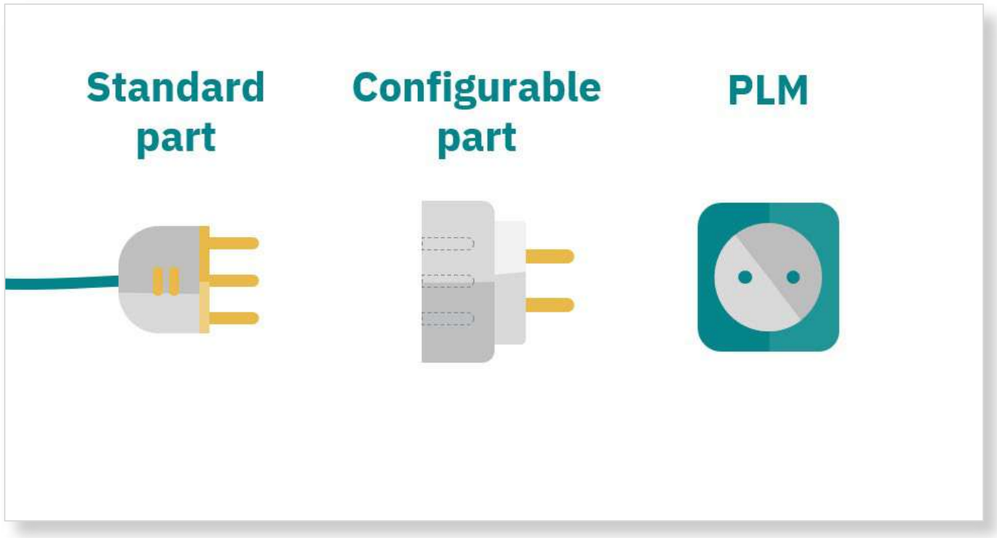
- 4 releases or
- 18 months

VOLTA API: verticalization examples

Use VOLTA APIs to interact with VOLTA content and its features.



runbox



VOLTA to PLM Connector

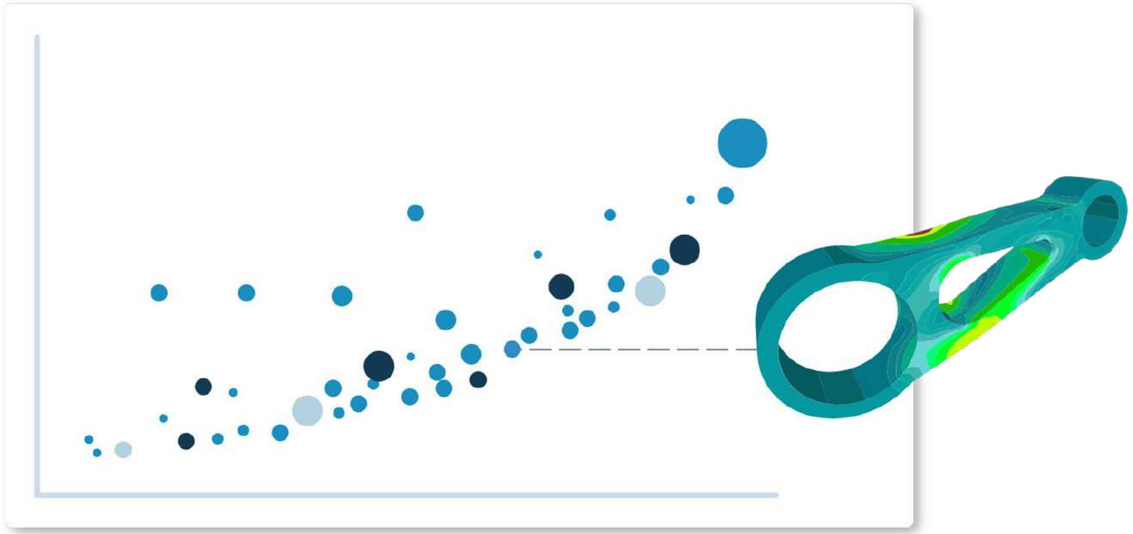
Future Direction

The evolution of pilOPT

This new optimization algorithm will build on the very successful pilOPT optimizer technology and will cover an even larger range of applications.

Focus on:

- High dimensional problems
- Intelligent use of existing information
- Effective Pause-Restart option



Connectors SDK

A toolset to build your Connector

Python API

Introspection, input parsing, output generation

Build automation tool

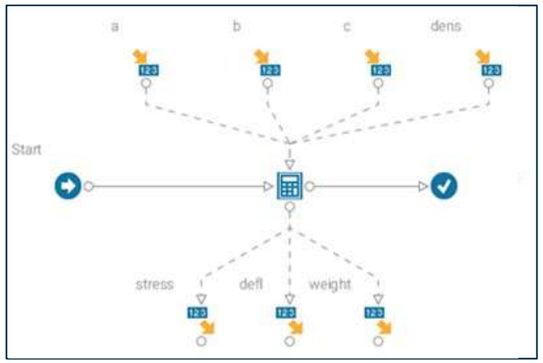
Automatically validate and build the Connector

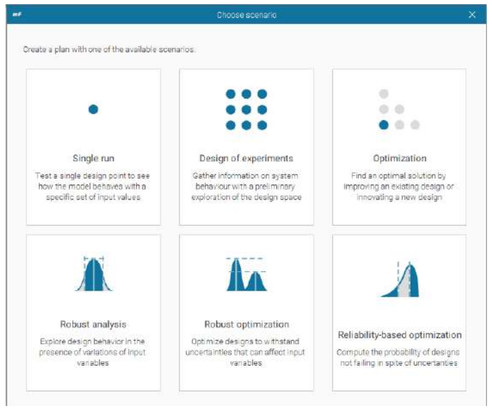
Documentation

Tutorials and reference material

Plan task node

- This new node will make it possible for the programmatic execution of Plans in the context of modeFRONTIER workflow.
- Plans can be introspected and executed, also sequentially, in the workflow



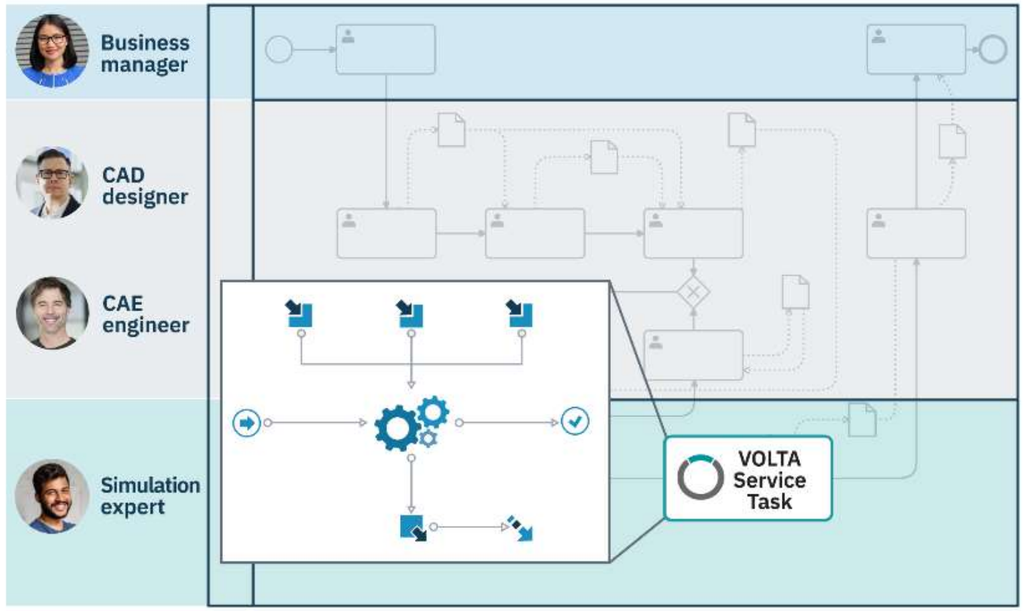


Service Task

Create services from a plan.

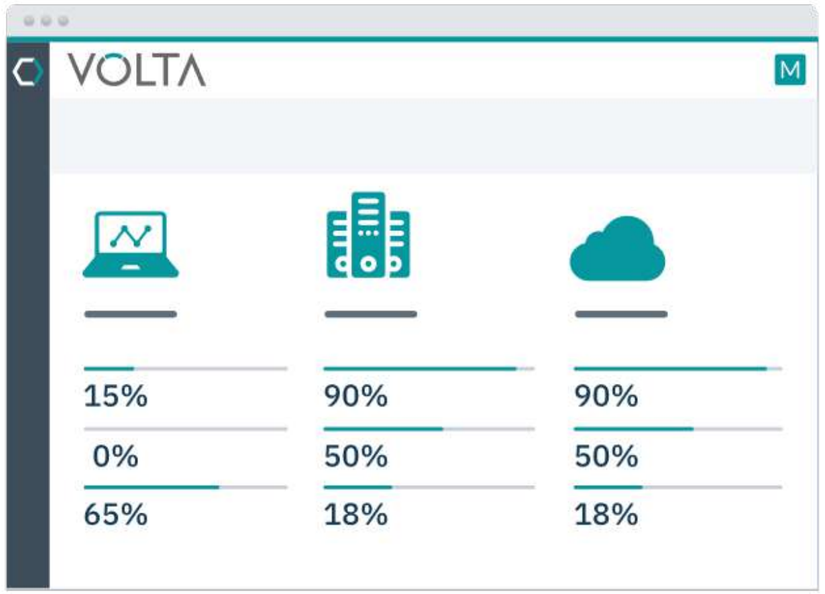
In BPMN: link business process level with the simulation workflow.

App: create and share simulation apps – future. Empowers democratization.



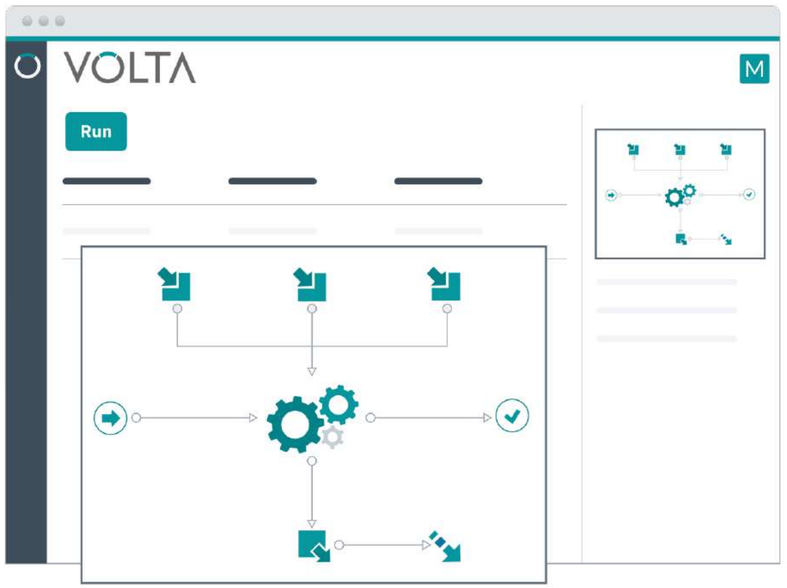
Workflow → Plan → Service → BPMN / standalone

New licensing scheme: what is all about



Execution

It comes at a fixed token price.



Simulation workflow

Run any workflow in any mode for a fixed token price and leverage distributed execution for complex MDAO studies.

Scale up with a simpler licenses scheme

New scheme

- Application Server
- Users
- Tokens*
- Optional Modules

*checkout **doesn’t depend** on workflow complexity, parallelization and submission type

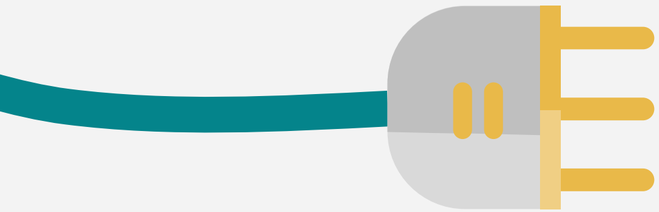
Old scheme

- Application Server
- Full Users
- Simulation Users
- Tokens**
- Optional Modules

checkout **depends on workflow complexity, parallelization and submission type

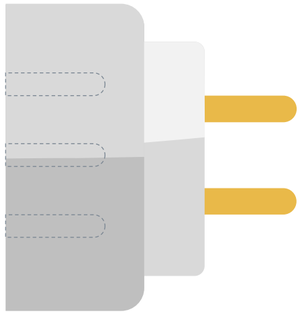
VOLTA to PLM connector

Standard part



Built in VOLTA, same for all customers.

Configurable part



Configuration needed for every customers’ PLM.

PLM

Adapter is configured to match Customer’s PLM.

Digital Thread

- Traceability to VOLTA from external systems: understand where models and data are coming from.
- Enable Digital Thread throughout your enterprise.

High Level Roadmap

What to expect in the next years

TODO

VOLTA Introspection
Actionate models on the web

Cameo Connector On Hold
Link VOLTA to requirements management

DOING

VOLTA to PLM Connector
Link VOLTA to other enterprise systems

VOLTA Service App
Create simulation services

VOLTA Cloud
New deployment option

Business Process Simulation
Simulation

3D Model Analyzer
CAE Post-processing in VOLTA Advisor

New Algorithm
Designed for an SPDM environment

Licensing
New VOLTA 2024R1 Licensing

DONE

VOLTA Service Task in BPMN
Create simulation services

Single Sign On
Improve VOLTA Security

TODO

Test run in CAD-CAE nodes
Test nodes before running the workflow

RSM training in the Planner
Schedule RSM training in your plan

Connectors SDK
Create your own direct interfaces

DOING

Plan task node
Run multiple plans in the workflow

pyFRONTIER
Drive pyCONSOLE from python application

New Algorithm
New self-adaptive optimizer

New batch JSON-based
New format for batch execution

DONE

Python bridge for DoE
Run python DoE in modeFRONTIER

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Thank you!

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