Ansys / DYNARDO | presented at the 17th Weimar Optimization and Stochastic Days 2020 |
Source: www.dynardo.de/en/library

optiSLang: recent developments

Dr. David Schneider

WOST 2020

Ansys

What possibilities are included in ANSYS optiSLang ?

Process integration

Workflow Building and Process Automation

Variation Analysis

Algorithms for robust design optimization

- Automated workflows
- Support all ANSYS tools
- Support 3rd party tools
- Open and flexible
- Build vertical apps
- Integration with Minerva
- "Simulation for non-simulation experts"

- Identify relevant parameters
- reduce complexity
- Understand your design
- Optimize your product with minimal effort
- Verify the robustness and reliability of your design
- Creates Data-based ROMs for digital twins

Variation analysis + Process integration

03:10 PM - 03:35 PM

Recent development in Metamodeling, Optimization and Reliability Algorithms

by Thomas Most (Dynardo GmbH)

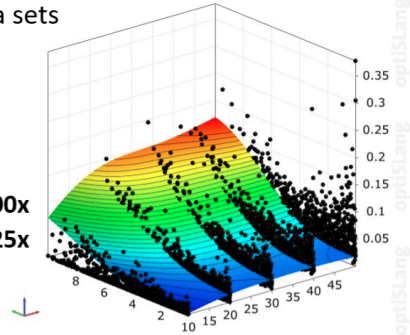
MOP Solver Performance (2020 R2)

- Significant improved performance for large data sets

Customer example 1

6000 data points, 7 inputs, 5 outputs

- Load file	10 min -> 3 sec	**Speedup 200x**
- Solve design	25 sec -> 0,2 s	**Speedup 125x**



Customer example 2

1500 data points, 22 inputs, 47 outputs

- Load file	15 min -> 1 min	**Speedup 15x**
- Solve design	20 sec -> 1,5 s	**Speedup 15x**

03:35 PM - 04:00 PM

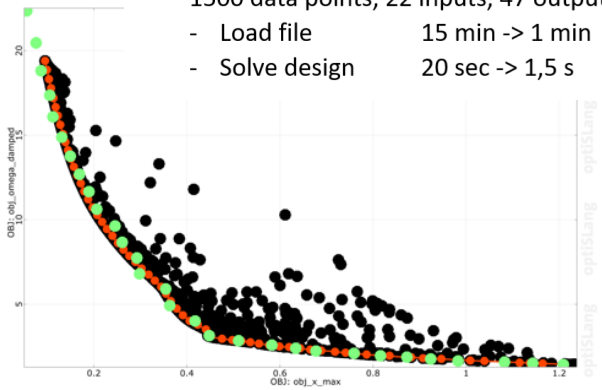
Recent developments and applications of Field Meta Modeling

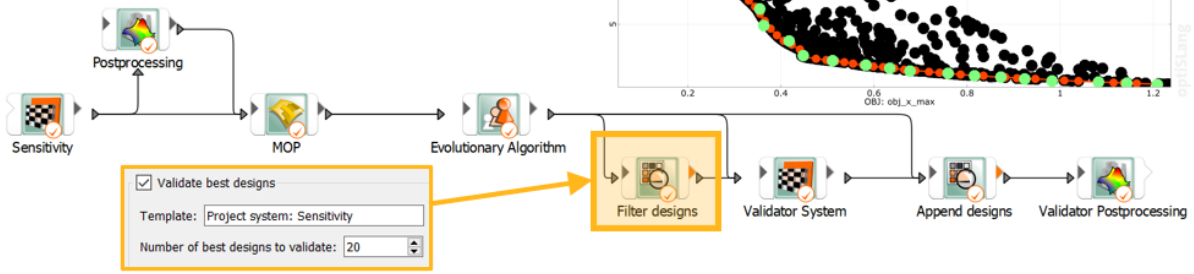
by Sebastian Wolff (ANSYS Austria GmbH)

Multi-objective Optimization on MOP

Validation of Pareto frontier

- Space-filling criterion to filter subset of well distributed Pareto optimal designs for validation





3. Process automation for field data in optiSLang

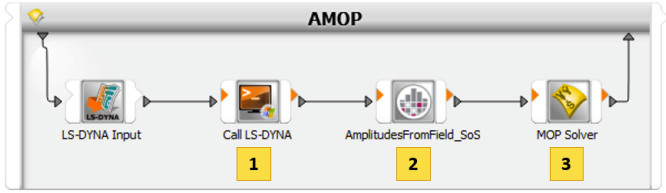
Innovation: Improved process nodes (**input** fields)

How does it work ?

- User prepares CAE solver or measurement that produces field output (e.g. a modified FEM mesh, a STL 3D measurement, a signal)
- User prepares SoS model that imports the file and projects the field data into scalar "parameters"

For each design:

1. optiSLang calls the CAE solver
2. optiSLang calls SoS to read CAE result and gets the scalar parameters
3. optiSLang uses the scalars, e.g. in (Field)MOP, as inputs to CAE solvers or in optimization goals



optiSLang - software neutral integration platform

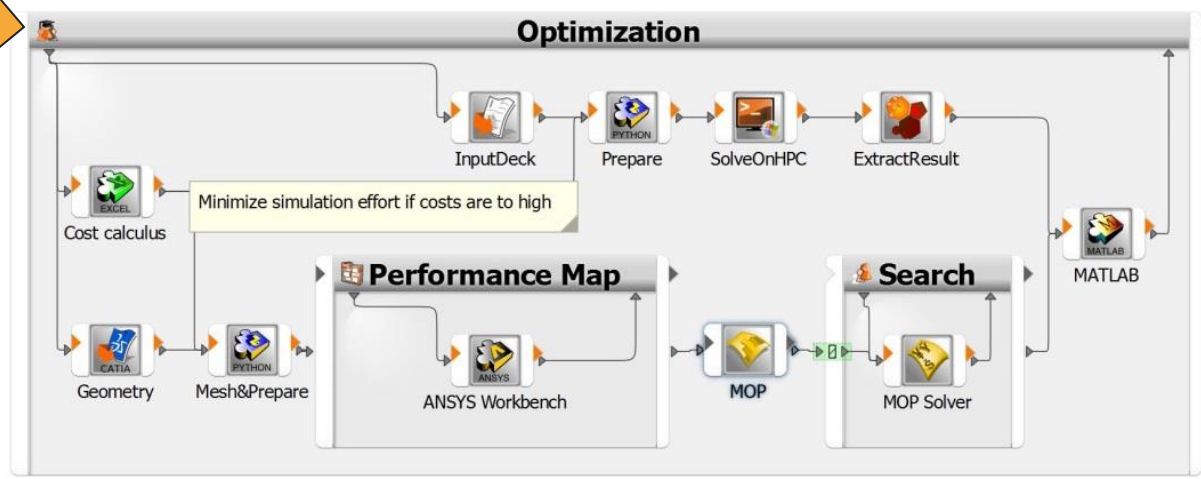
optiSLang connects

- Connect the tools our customers use
  - ANSYS
  - 3rd party
  - PLM
  - In-house

- CAx workflow management
  - Organize sequence/loops/conditions
    DOE, optimization, performance grid

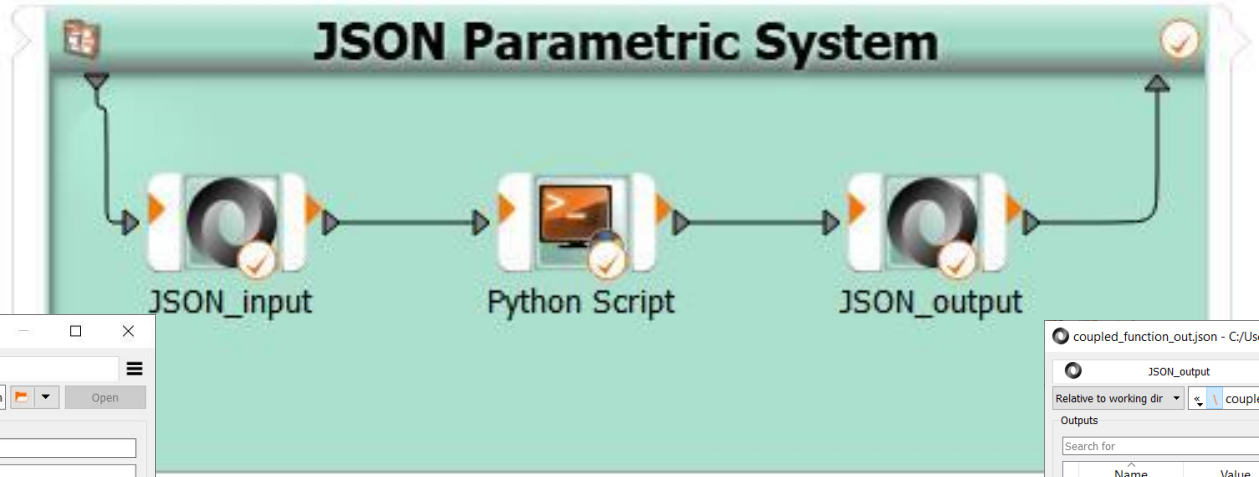
- Open architecture
  - Plugins
    for CAx Tools, Algorithms, PLM/Databases

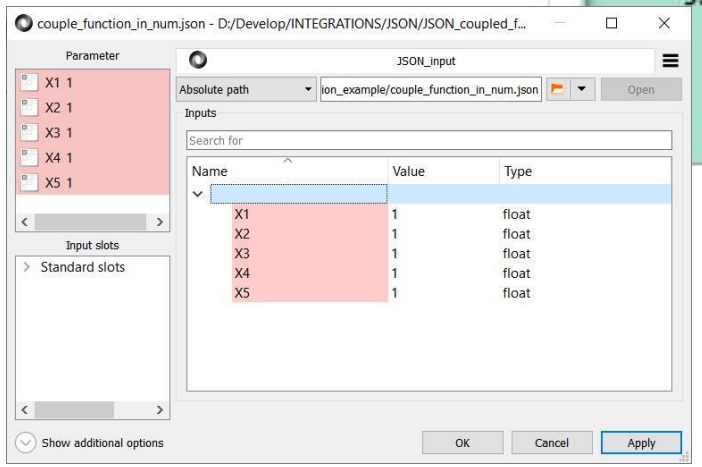
  - Interfaces
    Batch, Scriptable, Remote control

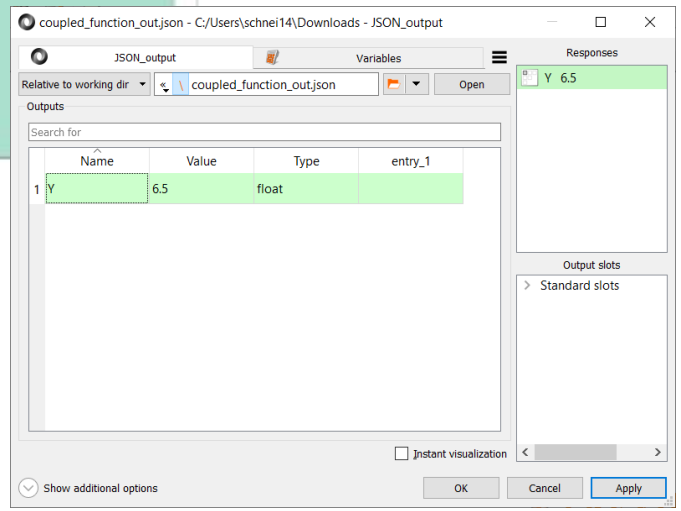


New integration node JSON

- Nodes
- Solver wizard

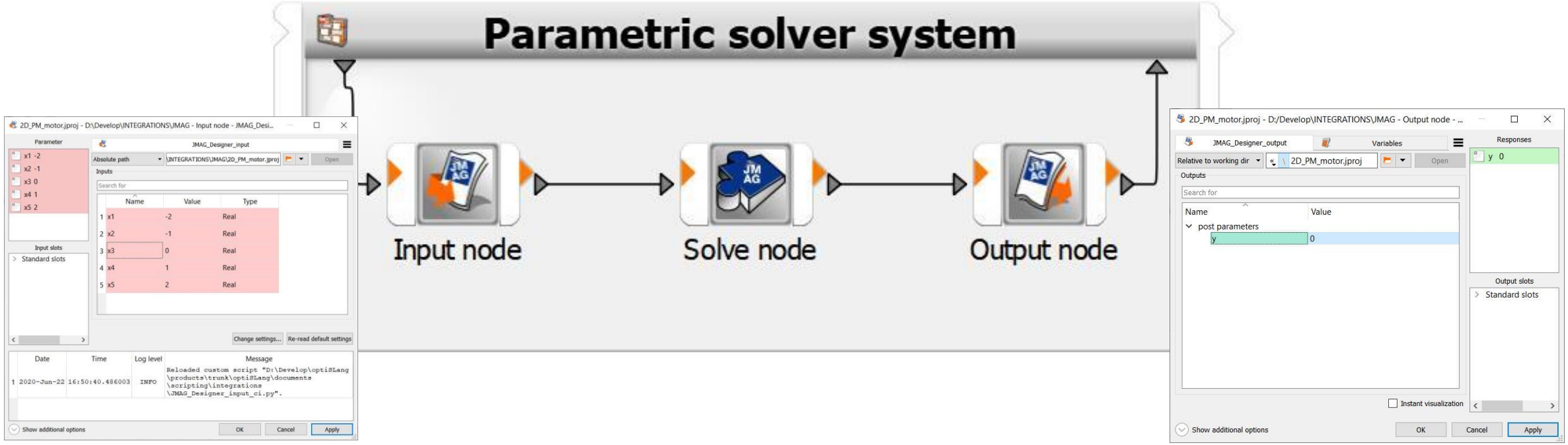






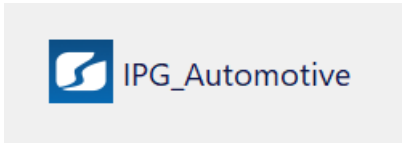
New integration node JMAG

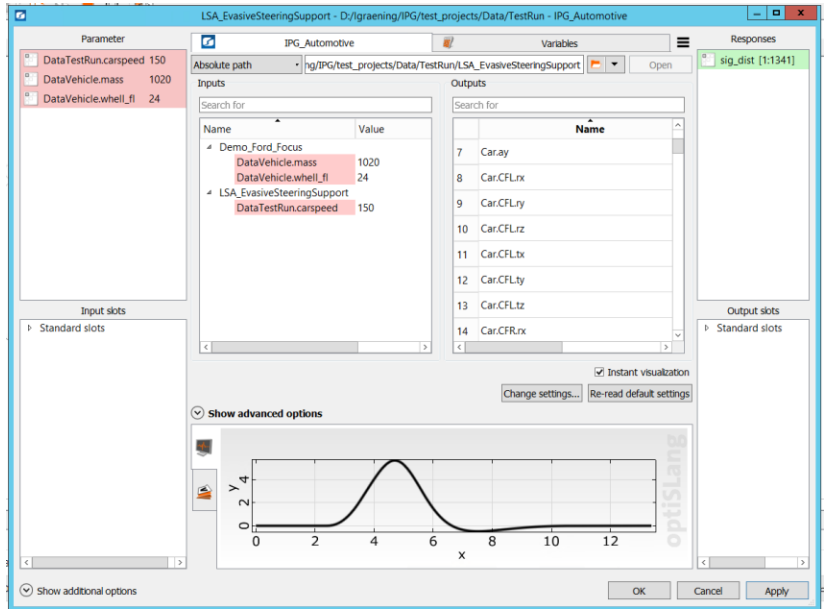
- Nodes
- Solver wizard

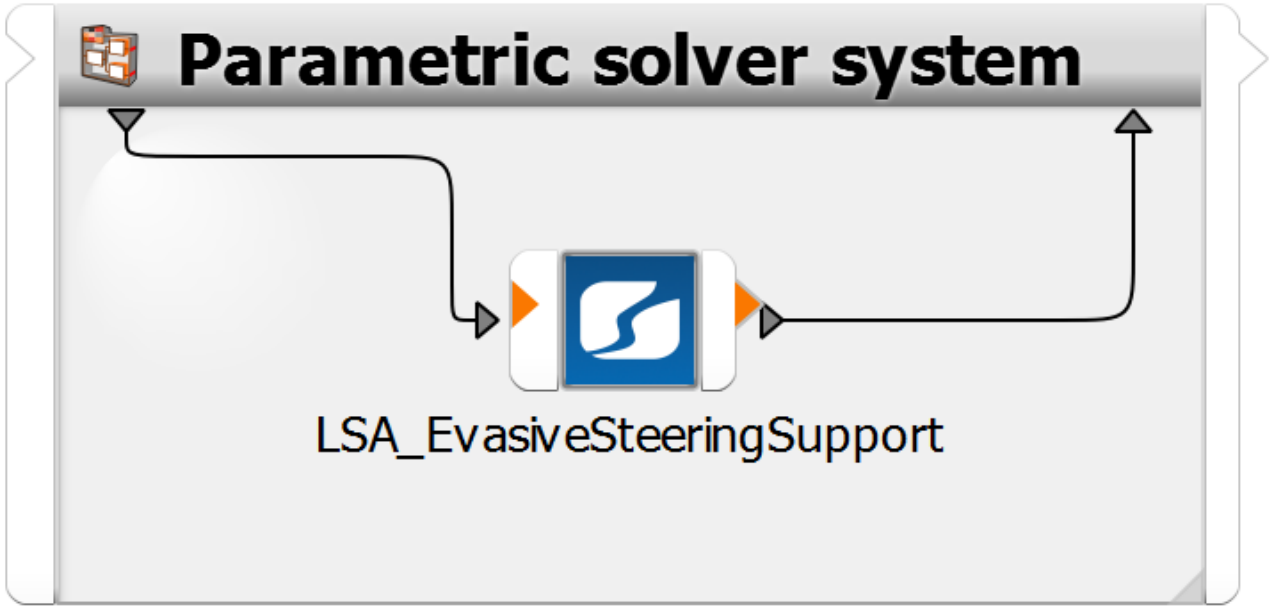


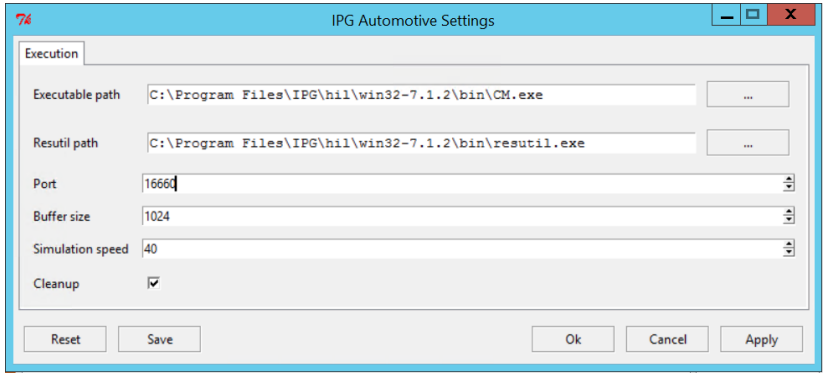
New integration node IPG

- Nodes
- Solver wizard



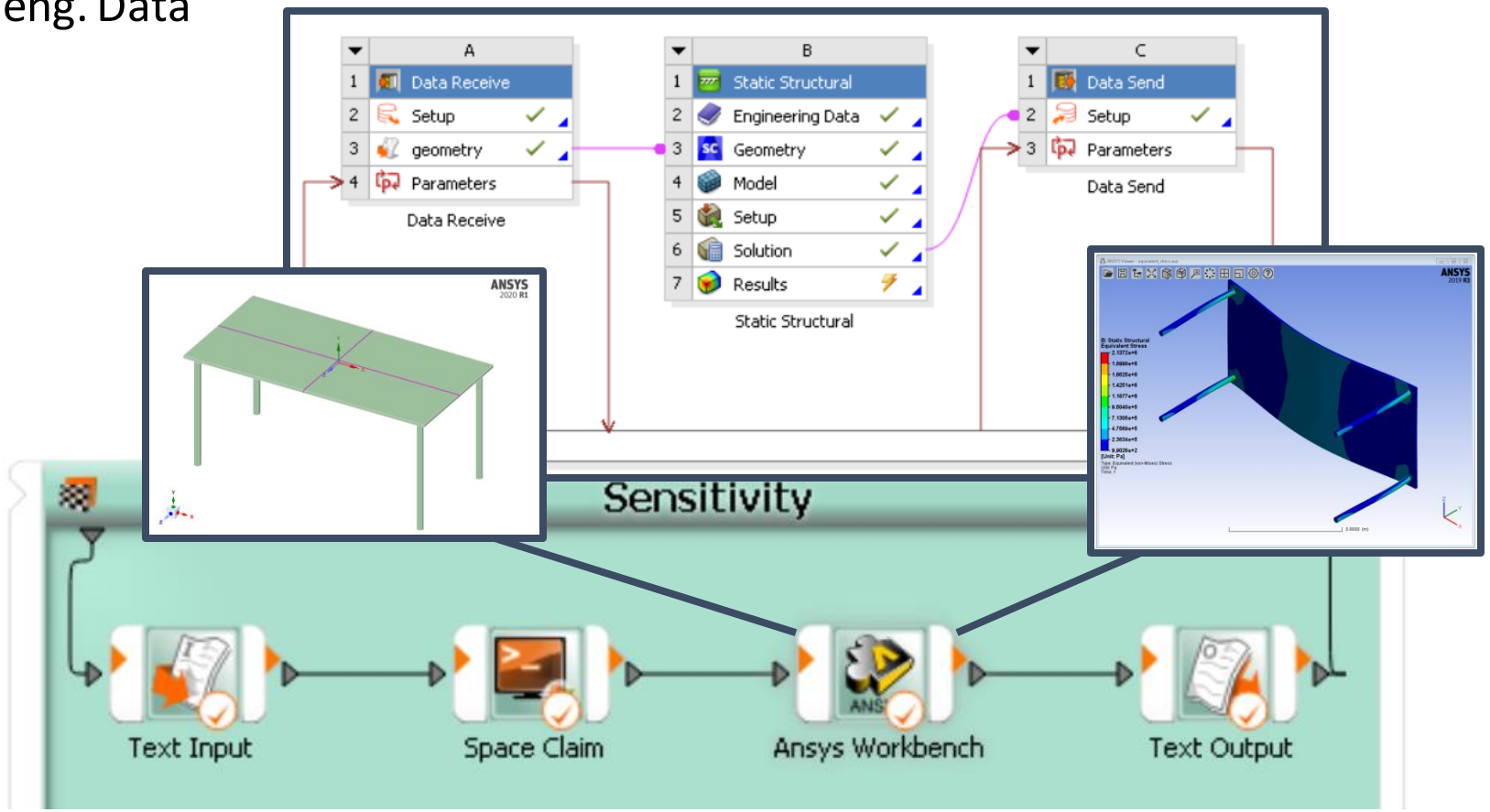






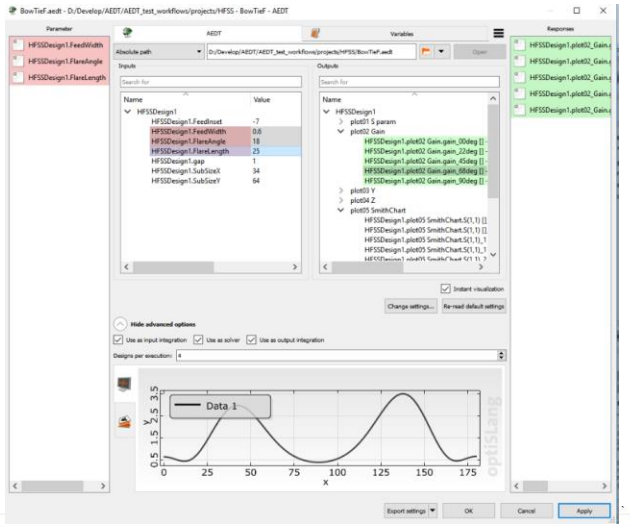
ANSYS Workbench Connector

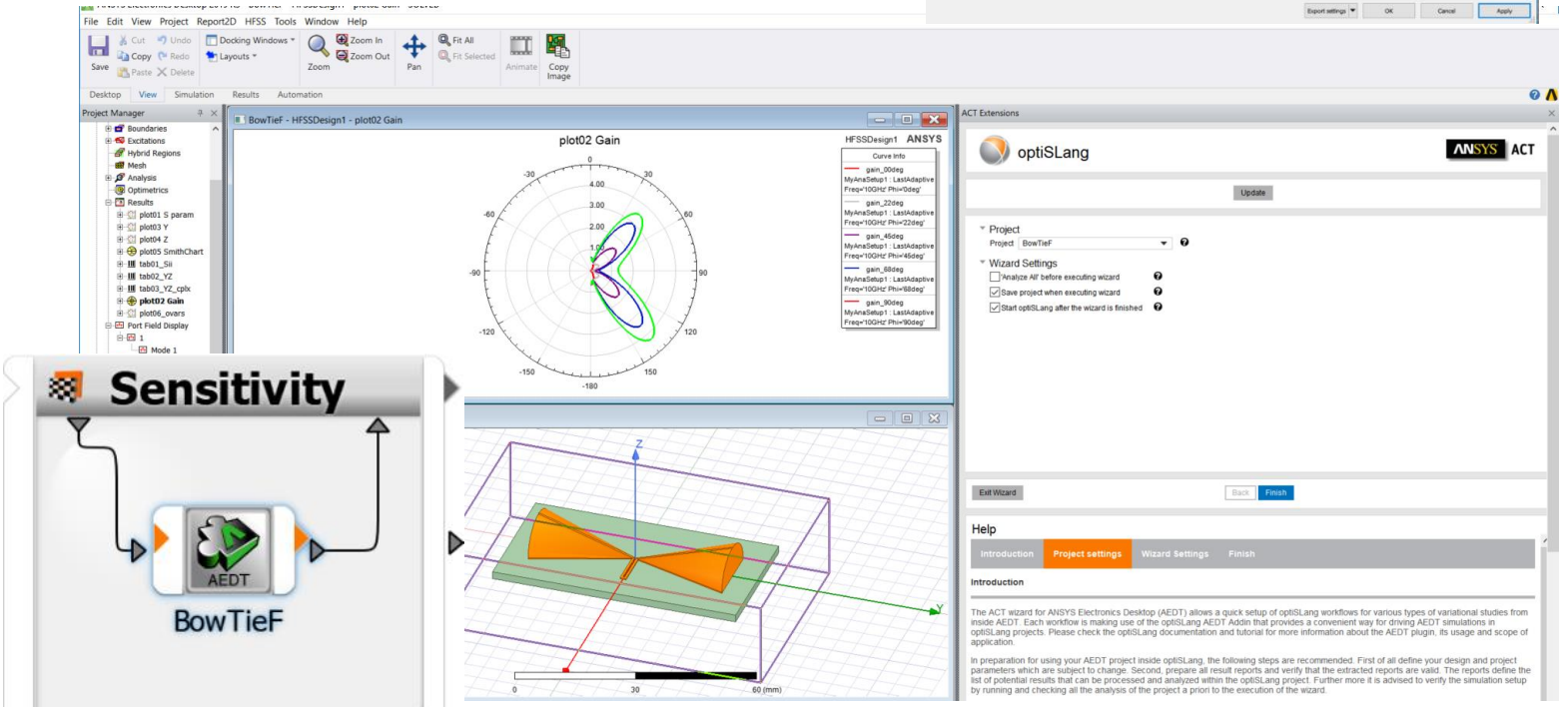
- New file-transfer option Workbench ←→ optiSLang project
  - Forward e.g. mesh/geometry/eng. Data
  - Send back results, avz
- AMOP connection
  - Inside Workbench
- Validation system
  - Inside Workbench



ANSYS Electronics Desktop Connector

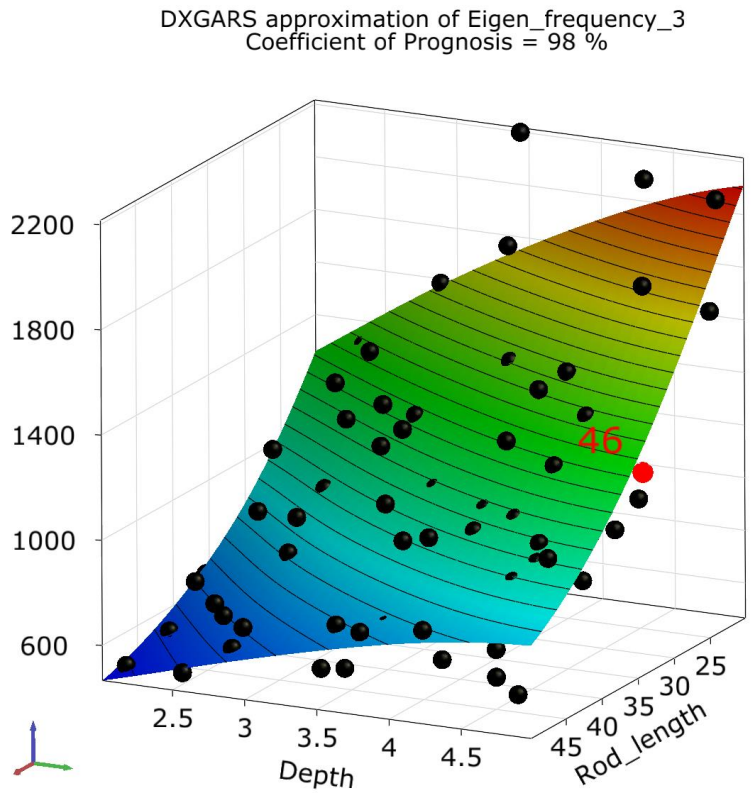
- New wizard: optiSLang inside AEDT (available as .wbex)
  - Wizard guided setup of workflow
- Supports Distributed Solve Option
- Significant reduction of redundant AEDT calls
- Improved project related meta data management





Integration of DX algorithms and meta-models

- Addin for using DX algorithms in optiSLang
- Implemented as custom algorithms and custom surrogate interfaces



Models	
Polynomials	
Use	☑ True
Order	2
Coefficient factor	2.00
Moving least squares	
Use	☑ True
Order	2
Coefficient factor	8.00
Kriging	
Use	☑ True
Anisotropic	☐ False
Coefficient factor	8.00
External	
ASCMO	☐ False
DXGARS	☐ False
DXKriging	☐ False
DXNPR	☐ False
DXPoly	☐ False
Feedforward_network	☐ False

Optimization method

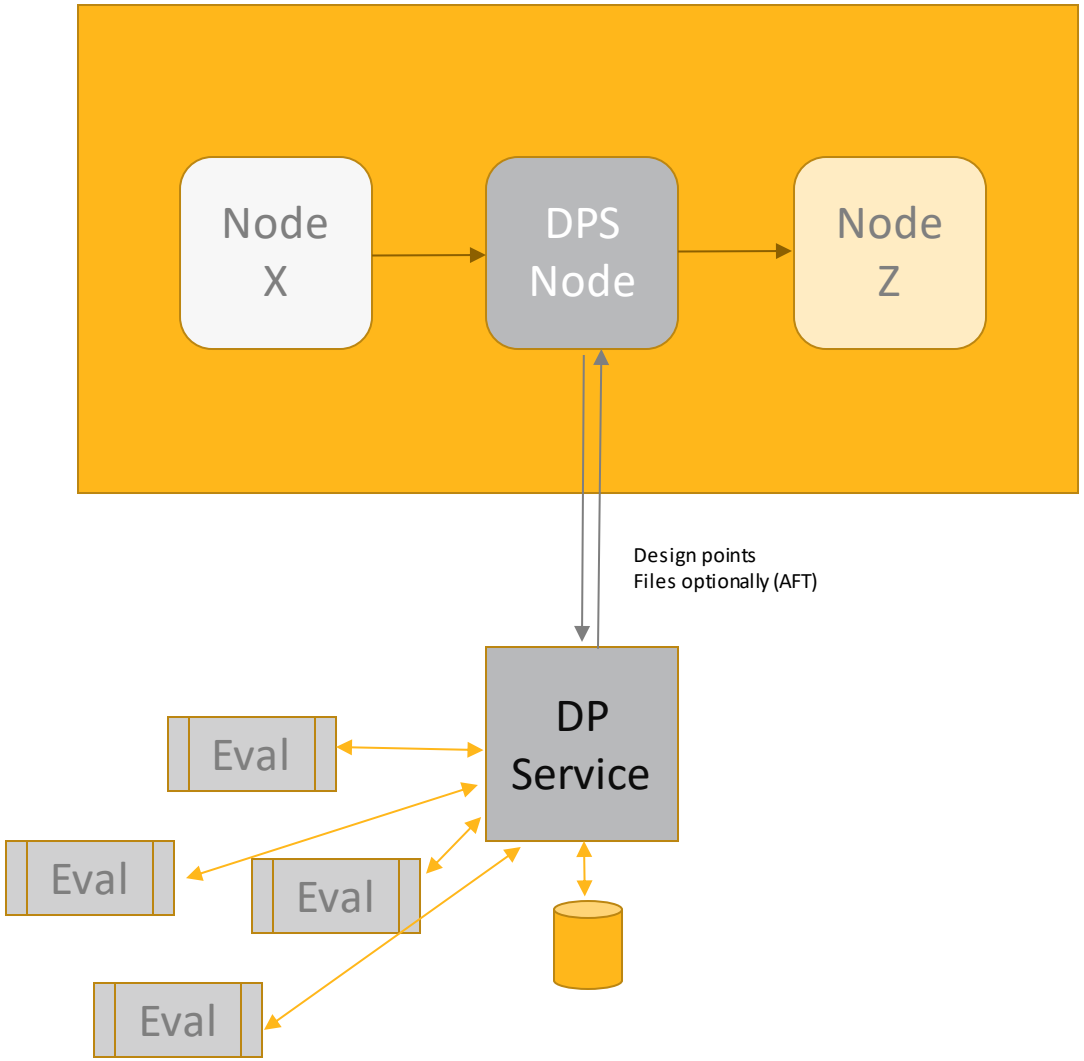
Gradient based
- ○ Non-Linear Programming by Quadratic Lagrangian (NLPQL)

Direct
- ○ Adaptive Response Surface Method (ARSM)
- ◉ Adaptive Metamodel of Optimal Prognosis (AMOP)
- ○ Downhill Simplex Method

Nature inspired
- ○ Evolutionary Algorithm (EA)
- ○ Particle Swarm Optimization (PSO)
- ○ Memetic (Beta)

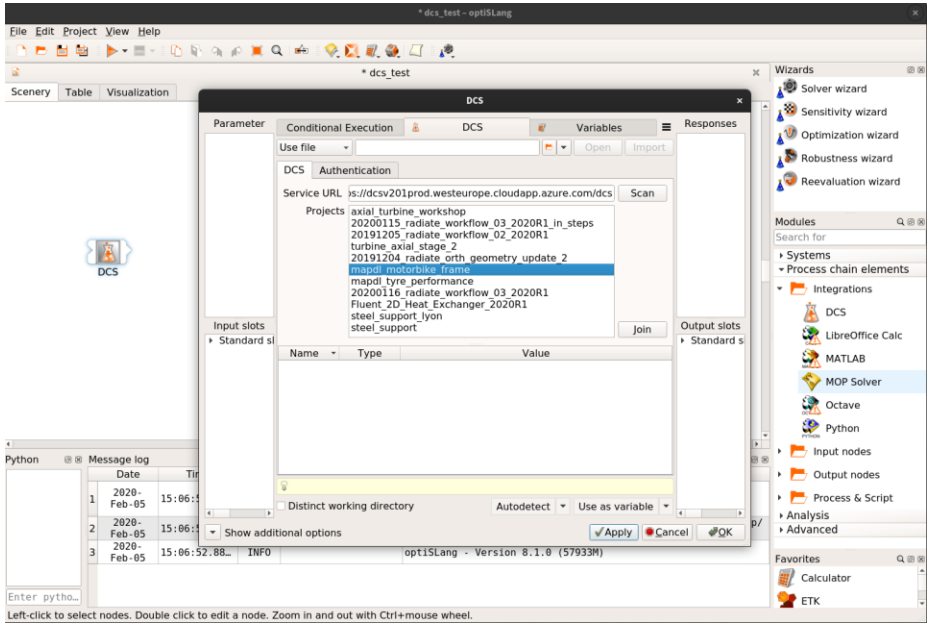
Plugins
- ○ DX - Adaptive Multiple-Objective
- ○ DX - Adaptive Single-Objective
- ○ DX - MISQP
- ○ DX - MOGA
- ○ DX - NLPQL
- ○ DX - Screening

Integration of Design Point Services (DPS) (Beta)



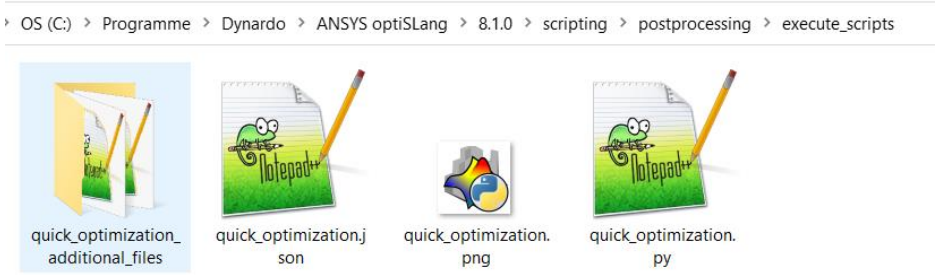
2020 R2

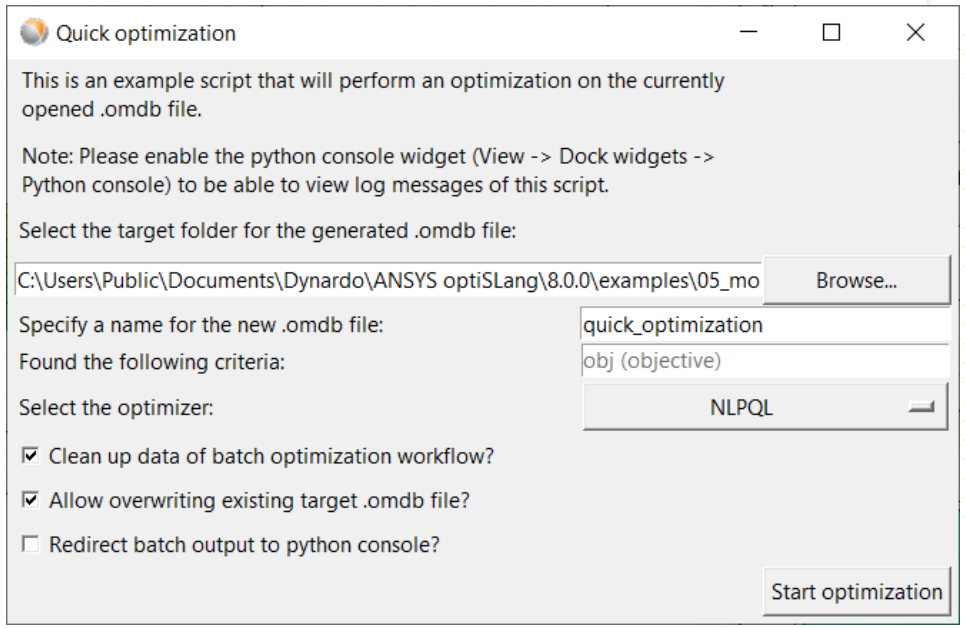
- DPS Integration Node
- Interfaces pre-existing projects
- Based on the Python client API
- Single design point update



Postprocessing: custom functions

- Define your helper function “behind a button”
- Optimizer inside Postprocessing comes as example






```
print("Using temporary directory: " + str(self.tmp_dir))

opf_name = "monitoring_script_opf.opf"
opf_path = os.path.join(self.tmp_dir, opf_name)
opd_path = os.path.join(self.tmp_dir, "monitoring_script_opf.opd")


# Create and save a new .omdb file for the script file to use
omdb_name = "monitoring_script_omdb.omdb"
omdb_path = os.path.join(self.tmp_dir, omdb_name)
self.control_container.save(omdb_path, False, True, False)

# Shorten "Evolutionary Algorithm" if selected to pass it as argument
if str(self.optimizer_value.get()) == "Evolutionary Algorithm":
    self.optimizer_value.set("EA")

# Start optislang with the selected script and the saved .omdb file as script argument
command = "\"" + str(self.optislang_exe) + "\" -b --new \"" + str(opf_path) + \
          "\" --python \"" + str(self.script_path) + \
          "\" --script-args \"'" + str(omdb_path).replace("\\","\\\\") + "' " + \
          str(self.optimizer_value.get()) + "\""
print("Executing script with optiSLang..")
if os.name == "nt":
    if self.redirect_output_value.get() == 0:
        process = subprocess.Popen(command)
        process.communicate()
    else:
        process = subprocess.Popen(command, stdout=subprocess.PIPE, stderr=subprocess.PIPE)
```

ANSYS optiSLang Innovations in 2020R2

Monitoring & Postprocessing

- Usage metrics
- Extended Node info log (incl. API)
- Import JSON

- Custom web-based monitoring
- Desktop App: Export Parameter bounds

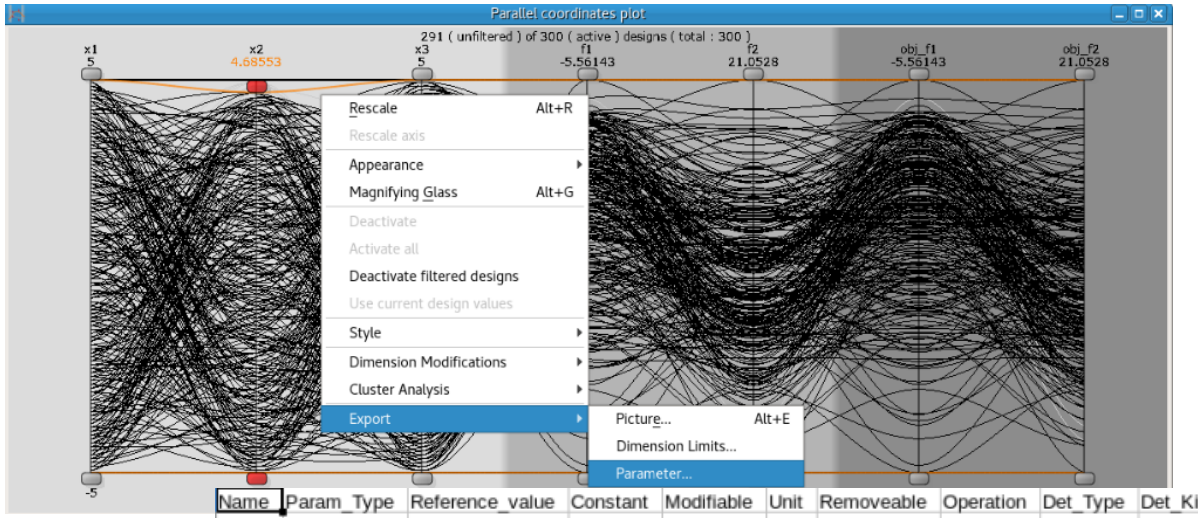
Actor Statistics

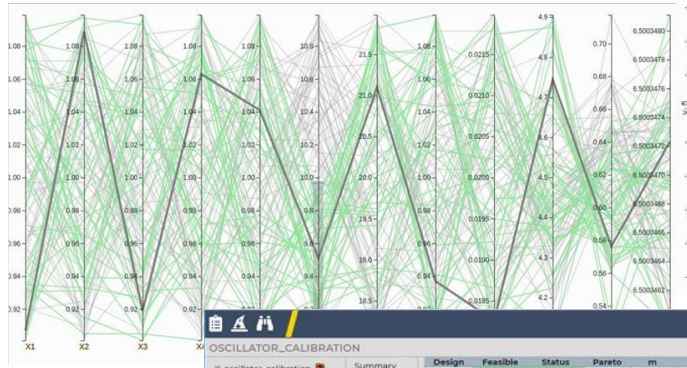
	Current Run	All Runs
Usages	400	400
Accumulated	0h 0m 17s 719ms	0h 0m 17s 719ms
Minimum	0h 0m 0s 15ms	0h 0m 0s 15ms
Maximum	0h 0m 1s 990ms	0h 0m 1s 990ms
Mean	0h 0m 0s 44ms	0h 0m 0s 44ms
σ	0h 0m 0s 193ms	0h 0m 0s 193ms

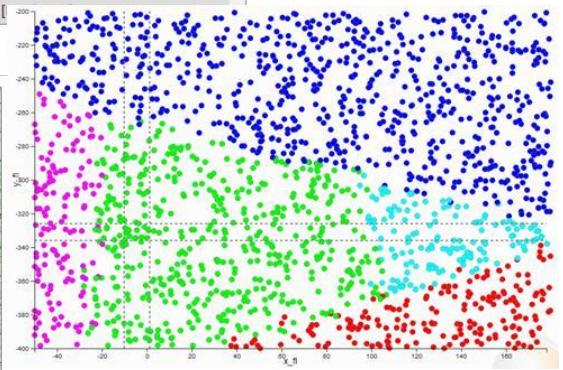
Actor Log

ERROR × WARNING × INFO ×

```
2020-Apr-28 17:50:57.134  INFO omega_damped: 2.4503196087
2020-Apr-28 17:50:57.134  INFO omega_damped: 2.3862939992
2020-Apr-28 17:50:57.134  INFO omega_damped: 2.8379613444
2020-Apr-28 17:50:57.134  INFO omega_damped: 2.58147244804 x_max: 0.753472122263
2020-Apr-28 17:50:57.194  INFO oscillator.py processed successfully in 0h 0m 1s 943ms [Design 4]
2020-Apr-28 17:50:57.194  INFO oscillator.py processed successfully in 0h 0m 1s 958ms [Design 3]
2020-Apr-28 17:50:57.194  INFO oscillator.py processed successfully in 0h 0m 1s 990ms [Design 1]
2020-Apr-28 17:50:57.194  INFO oscillator.py processed successfully in 0h 0m 1s 975ms [Design 2]
2020-Apr-28 17:50:57.290  INFO omega_damped: 2.41109066235 x_max: 2.14080120183
2020-Apr-28 17:50:57.303  INFO omega_damped: 2.51078342657 x_max: 1.52932884559
2020-Apr-28 17:50:57.306  INFO oscillator.py processed successfully in 0h 0m 0s 24ms [Design 5]
2020-Apr-28 17:50:57.335  INFO oscillator.py processed successfully in 0h 0m 0s 40ms [Design 6]
2020-Apr-28 17:50:57.336  INFO omega_damped: 3.14273601253 x_max: 1.68750206097
2020-Apr-28 17:50:57.354  INFO omega_damped: 1.98365280824 x_max: 2.40242549773
2020-Apr-28 17:50:57.365  INFO oscillator.py processed successfully in 0h 0m 0s 38ms [
```



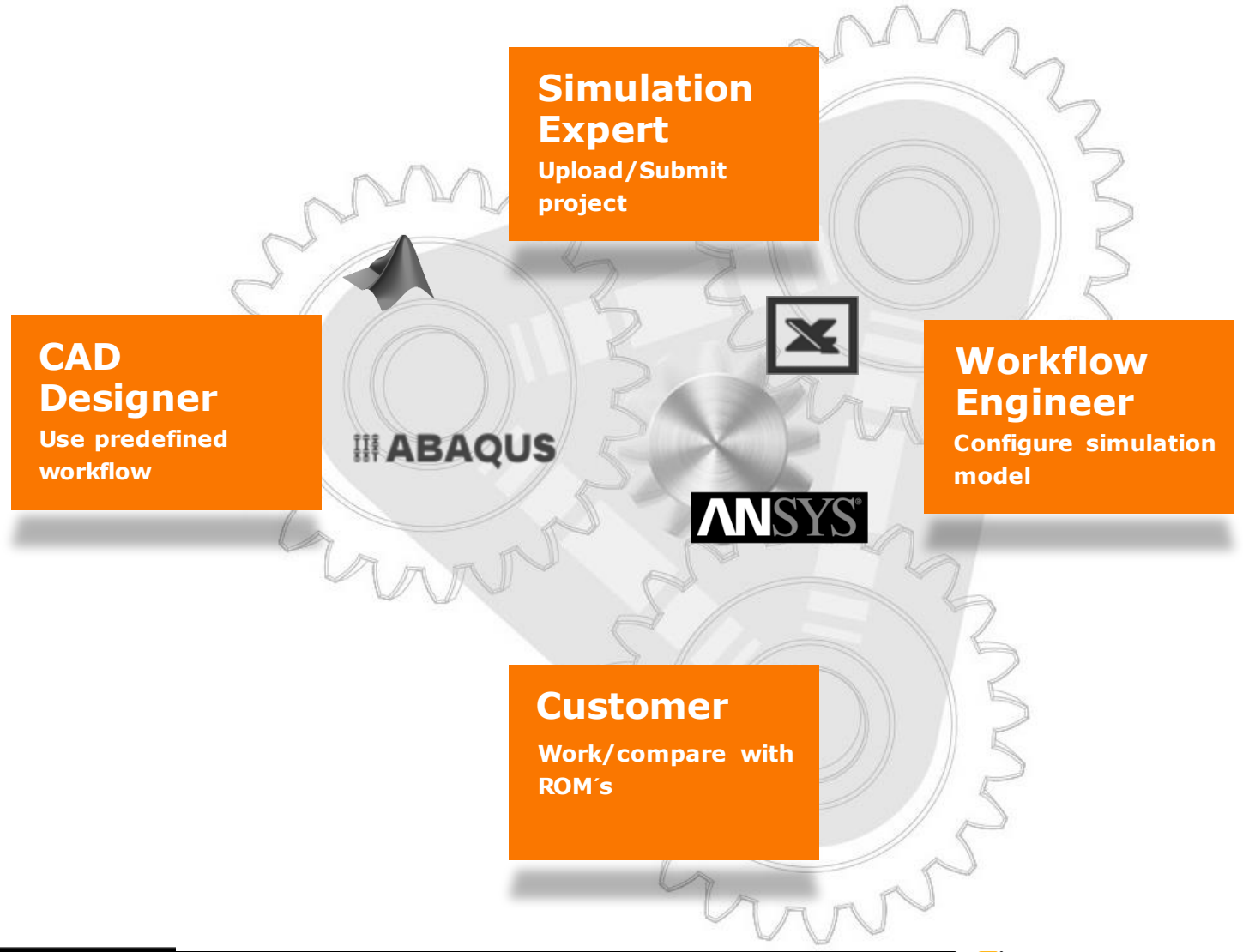




Name	Param_Type	Reference_value	Constant	Modifiable	Unit	Removeable	Operation	Det_Type	Det_Kind	Det_Range
x1	Optimization	0	0	0		1		REAL	Continuous	-5:5
x2	Optimization	0	0	0		1		REAL	Continuous	-5:4.68553
x3	Optimization	0	0	0		1		REAL	Continuous	-5:5

Democratization

- Easy access for non-experts
- Simulation/Automation by experts
- Centrally Workflow Management
- Traceability
- Reusability
- Standardization

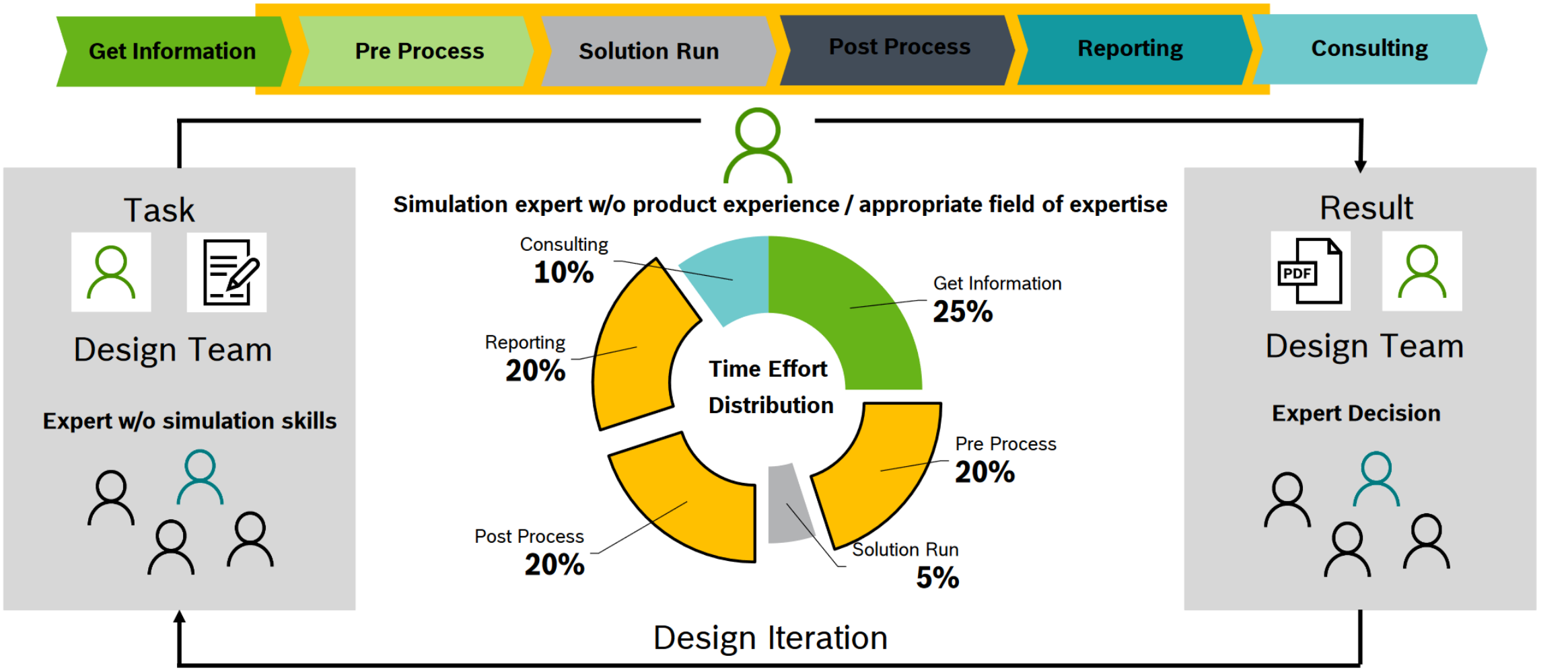


Interactive process automation and integration for every entry scenario is guided and supported by wizards and default settings.

Democratization of CAE-Workflows with optiSLang @ Bosch

Simulation Process Management (SPM)

dynardo dynamic software & engineering

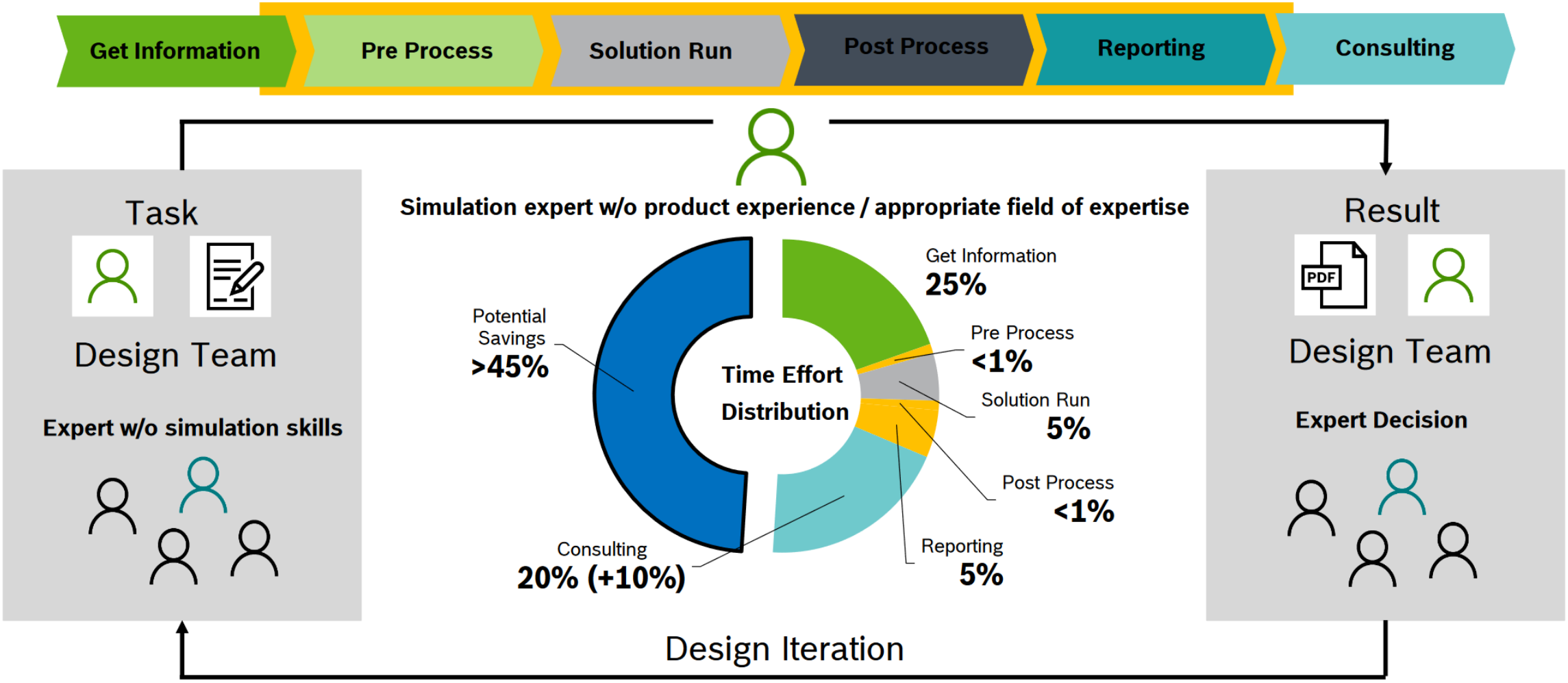


D. KRÄTSCHMER: DEMOCRATIZATION OF CAE-WORKFLOWS WITH OPTISLANG AT BOSCH, WOSD, 2019, Weimar, Germany

Democratization of CAE-Workflows with optiSLang @ Bosch

Target State: Expected Savings

dynardo dynamic software & engineering



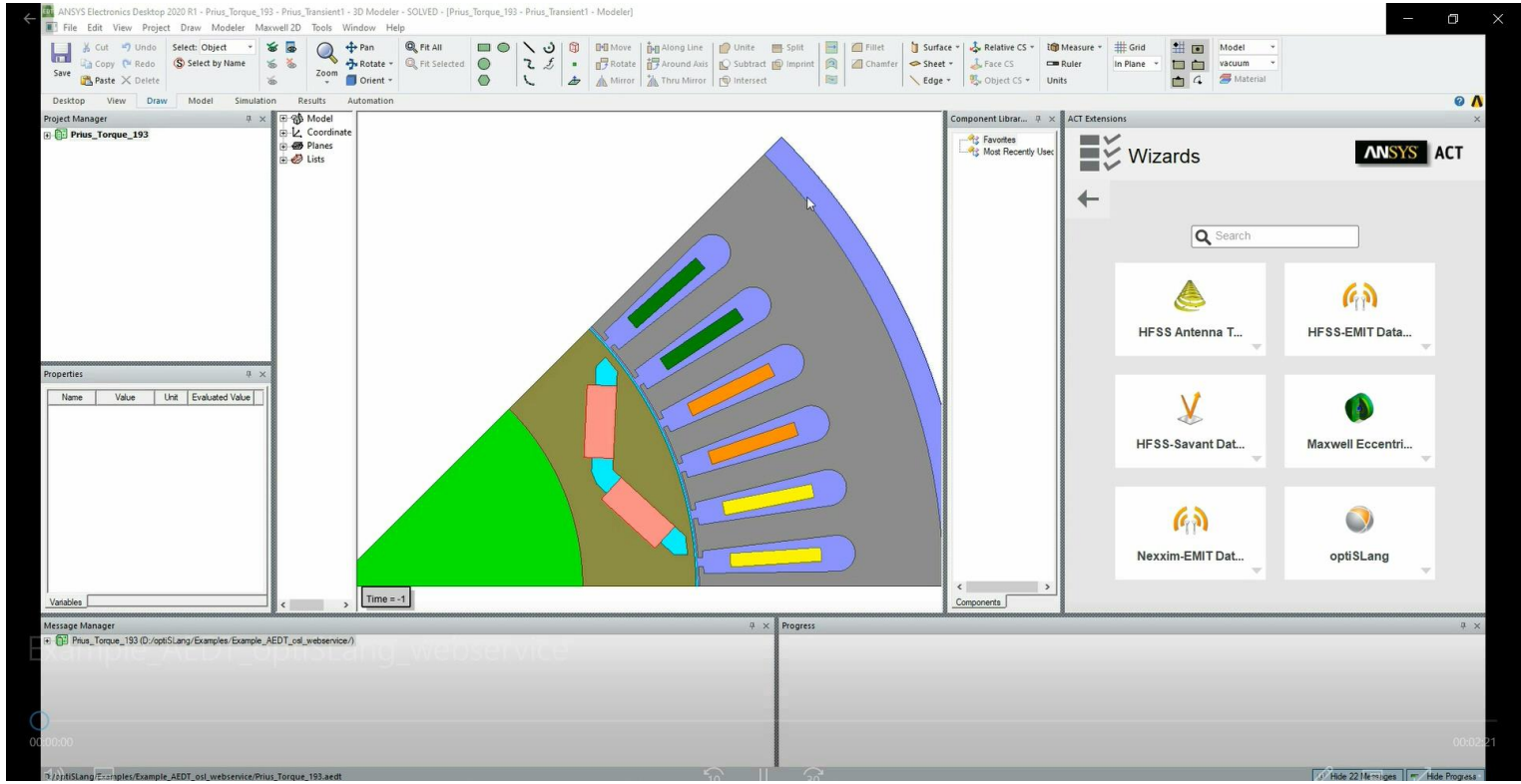
D. KRÄTSCHMER: DEMOCRATIZATION OF CAE-WORKFLOWS WITH OPTISLANG AT BOSCH, WOSD, 2019, Weimar, Germany

Include AEDT project in simulation workflow

- Wizard based setup in AEDT

- optiSLang wizards help
  - Parametrize inputs/outputs
  - Choose algorithm

- optiSLang workflow is created

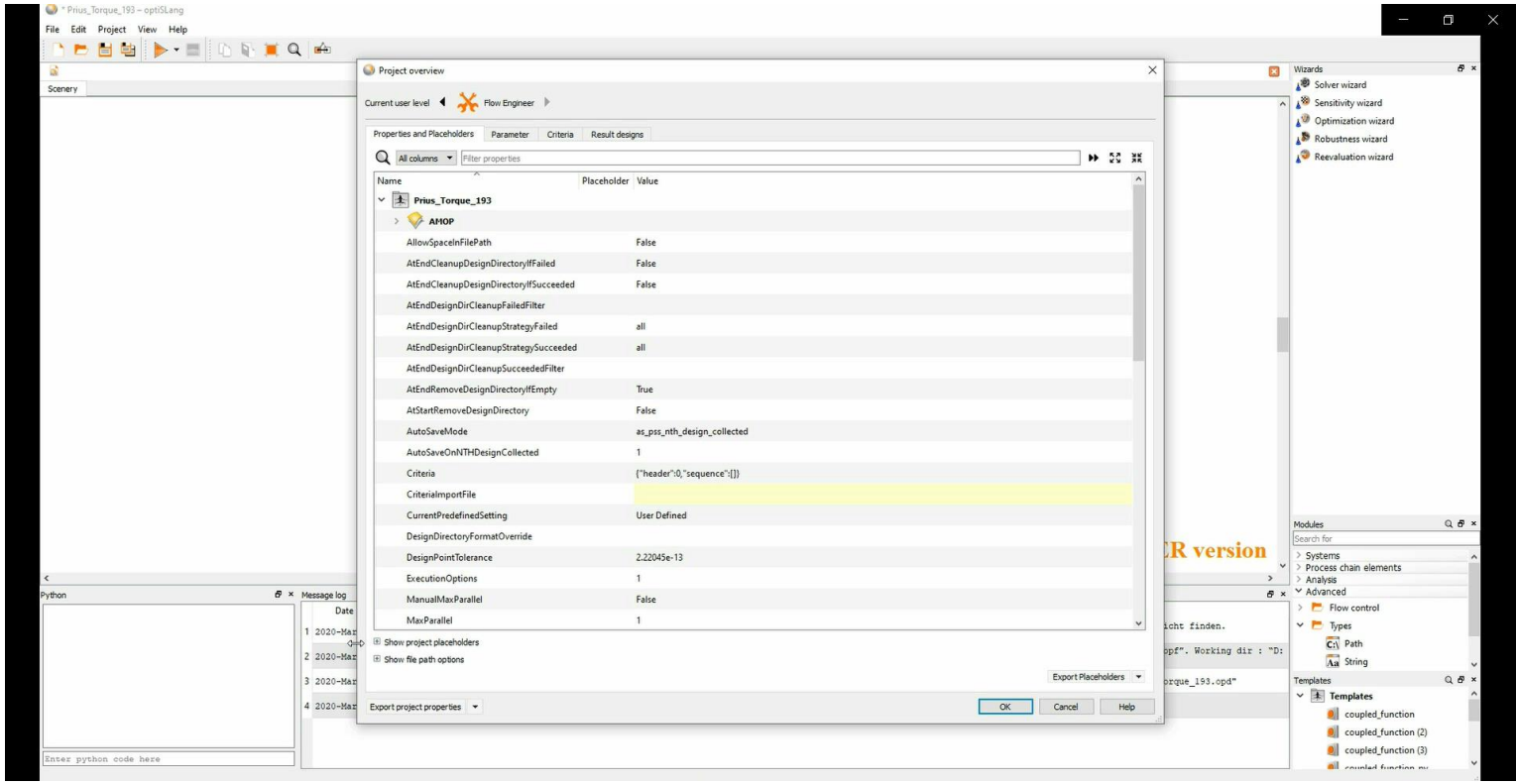


**Wizard is part of the optiSLang installer*

Set up + (extend) simulation workflow

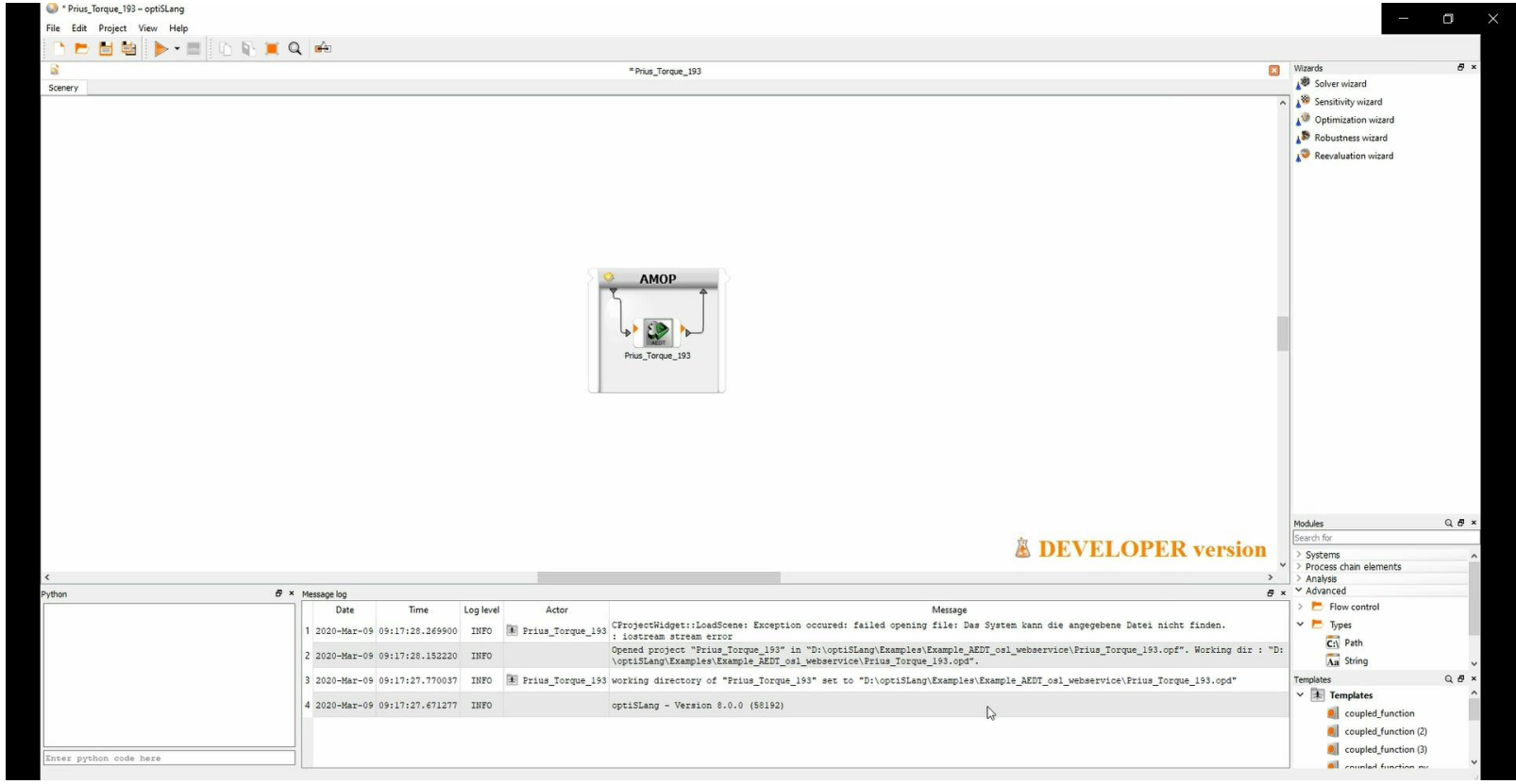
Use full power of optiSLang

- Add other nodes/algorithms
  - e.g. next AEDT project
  - Pre/postprocessing
  - …
- Set e.g. execution settings
  - Number of parallel runs
  - DSO
  - …
- Parametrize the workflow
  - Access to all settings in project
  - Define possible “parameters”



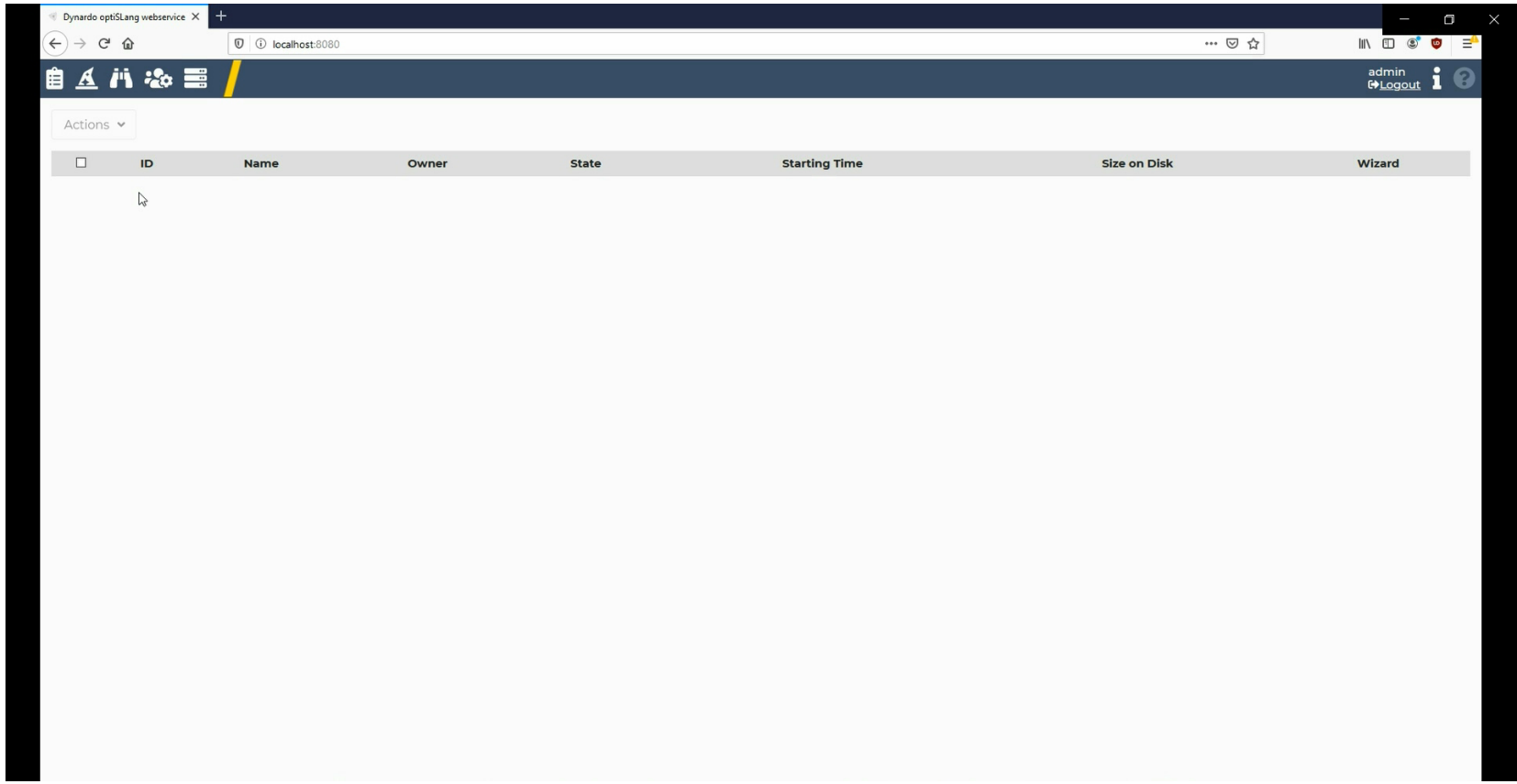
Publish / Democratize

- Save project to …
- Automatically
  - Creates Web-App
  - Uploads to Webserver
- Customization possible



Web-App: Access in browser

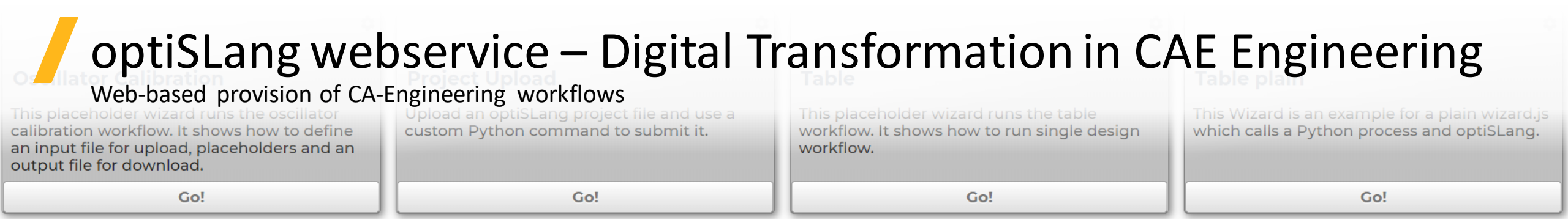
- No desktop installation needed
- Only “understandable” settings
- Project monitoring
  - Standard or customizable



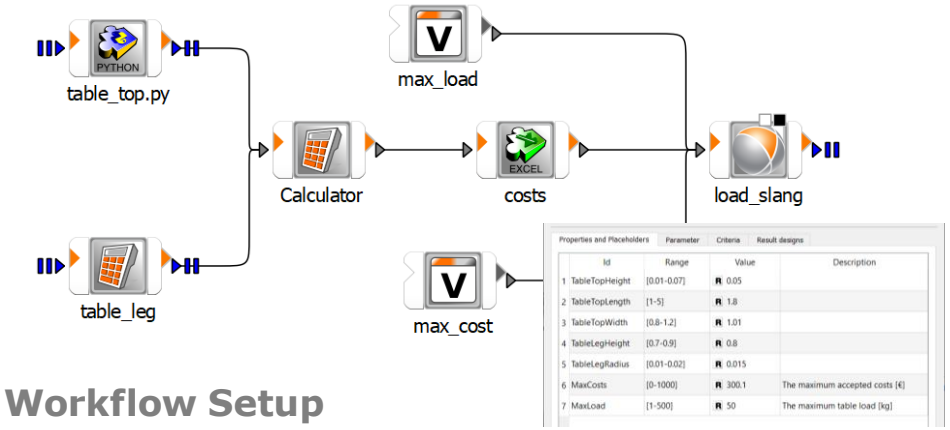
➔ Simulation for non-simulation experts

optiSLang webservice – Digital Transformation in CAE Engineering

Web-based provision of CA-Engineering workflows



Task node(s):Pool



Workflow Setup

App Definition

outstanding

Efficiency

by consequent baselining and reuse of CAE engineering processes

Table parameter

Name	Value	Unit
Leg radius	0,05	m
Leg height	0,7	m
Plate length	1,2	m
Plate width:	0,7	m
Plate height:	0,01	m
Total costs:	159.62	€
Load:	200	kg

Run optiSLang

Web-based User Interface

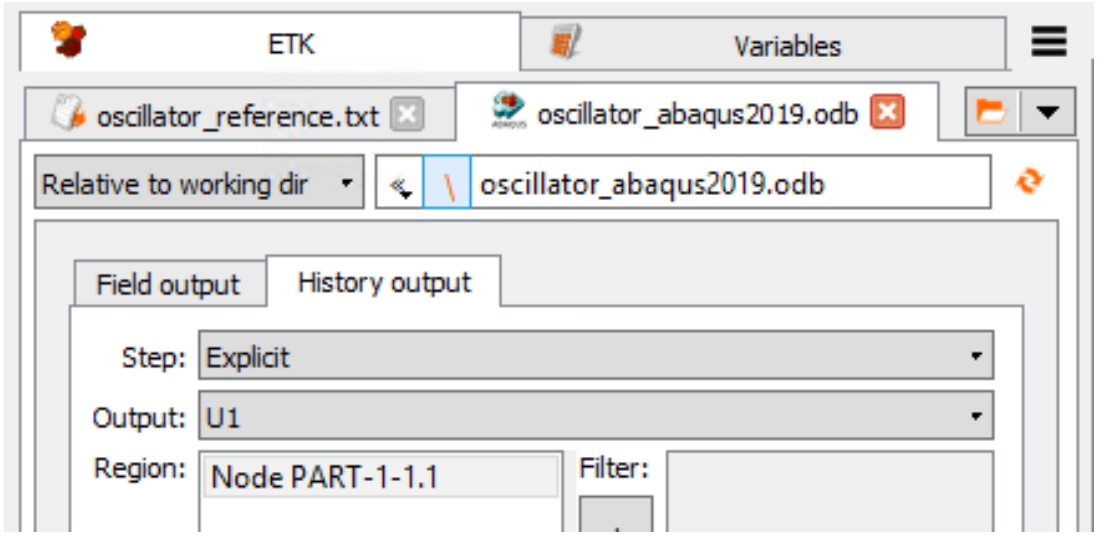
Strong focus on workflows and processes with tailorable user Interfaces

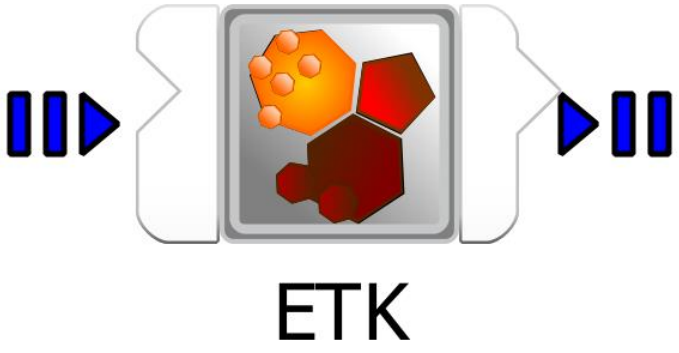
ANSYS optiSLang Innovations in 2020R2

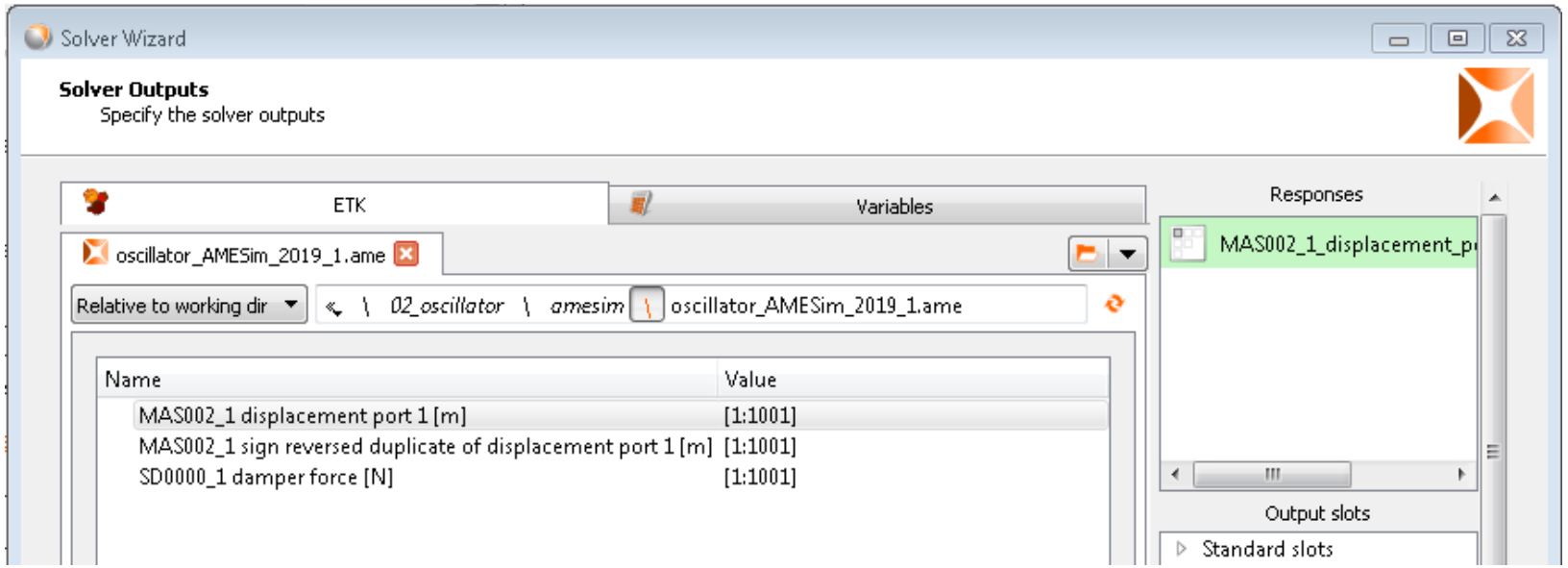
Extraction Tool Kit

Now part of Ansys optiSLang license

Interfaces to extract results from
Abaqus – odb files
Adams – res files
Amesim – ame files

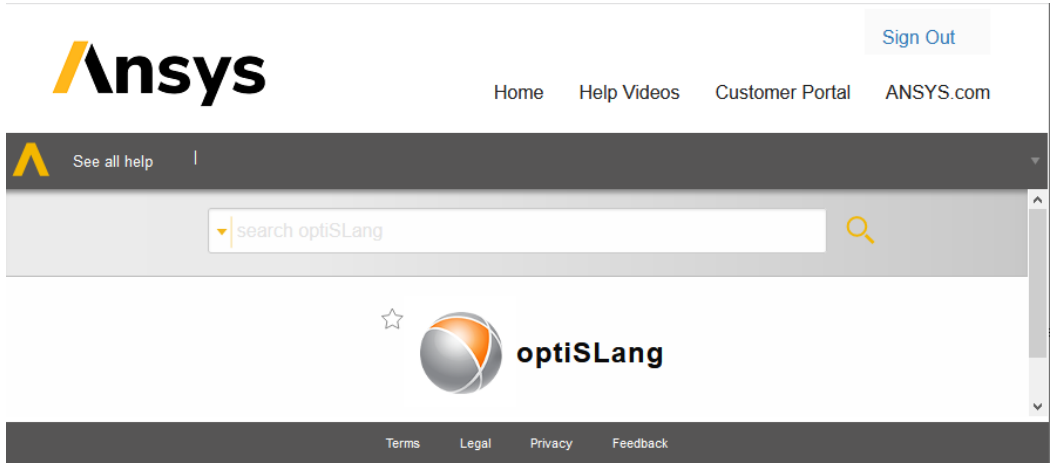


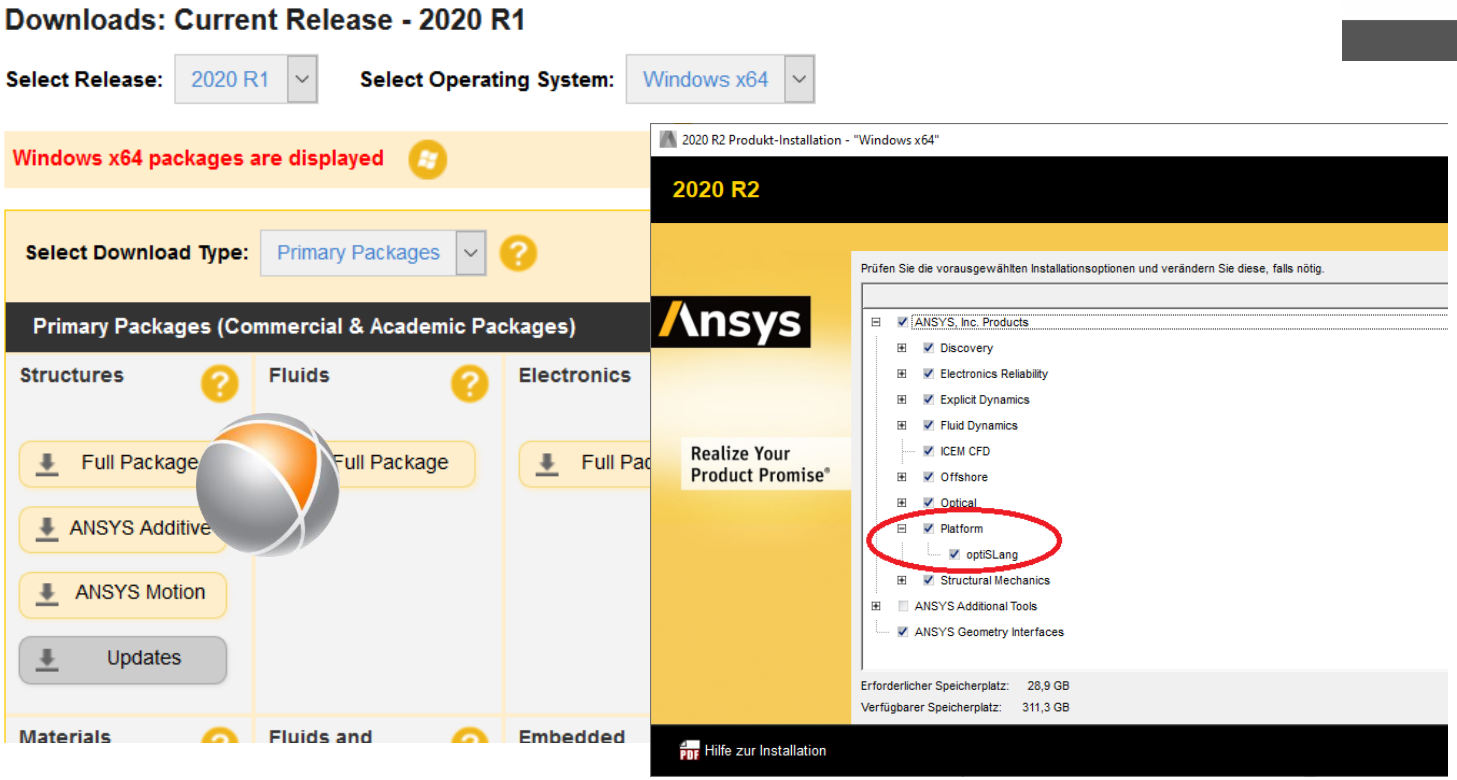




„Unified Installer“ + Documentation

- ***!!! Additionally !!!***
- optiSLang part of Ansys Installers
- optiSLang documentation in Ansys help system





optiSLang Tutorials

optiSLang – recent developments

Algorithms

- DesignXplorer algorithms
- New Nature Inspired Optimizer (beta)
- Data based distribution fit
- Deep Learning Extension
- FieldMOP - FMU

Integrations

- AEDT
- Workbench
- IPG, JMAG, JSON
- DPS (beta)
- SoS Addins
- Python „use slot values“
- Performance & updates

Postprocessing

- Custom functions button
- Datamining: N-best designs
- Export parameter bounds
- Web-monitoring
- Usage statistics

Interface

- optiSLang webservice
- Register project
- SDK for WebApps

Licensing

- Licensing Dialog
- ETK→ optiSLang
- Prepare: SoS → optiSLang

Infrastructure

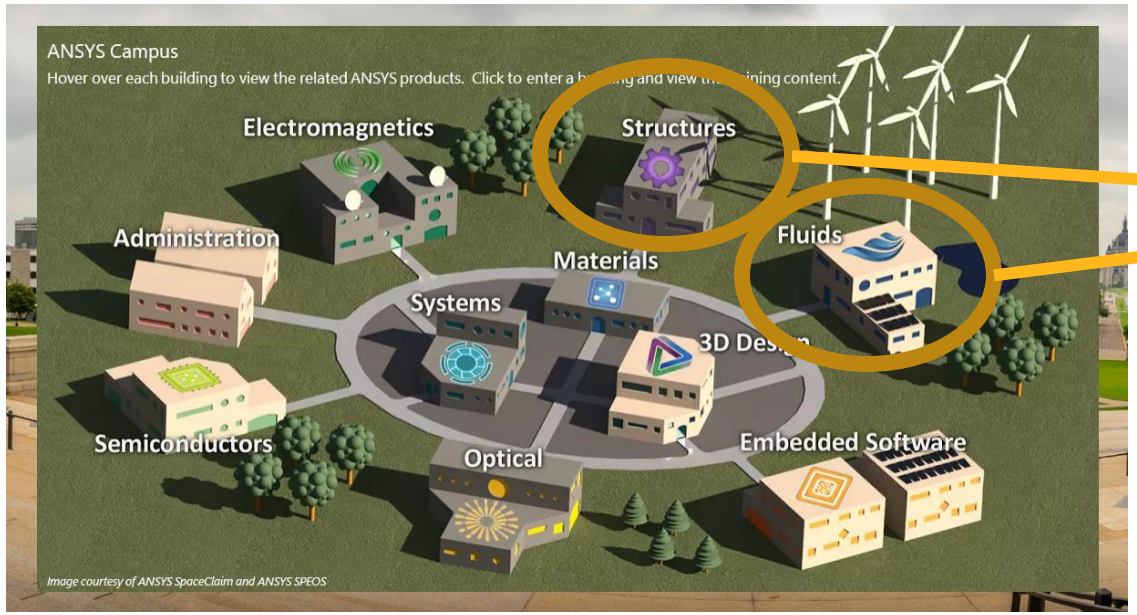
- Unified installer
- Documentation
- Python 3

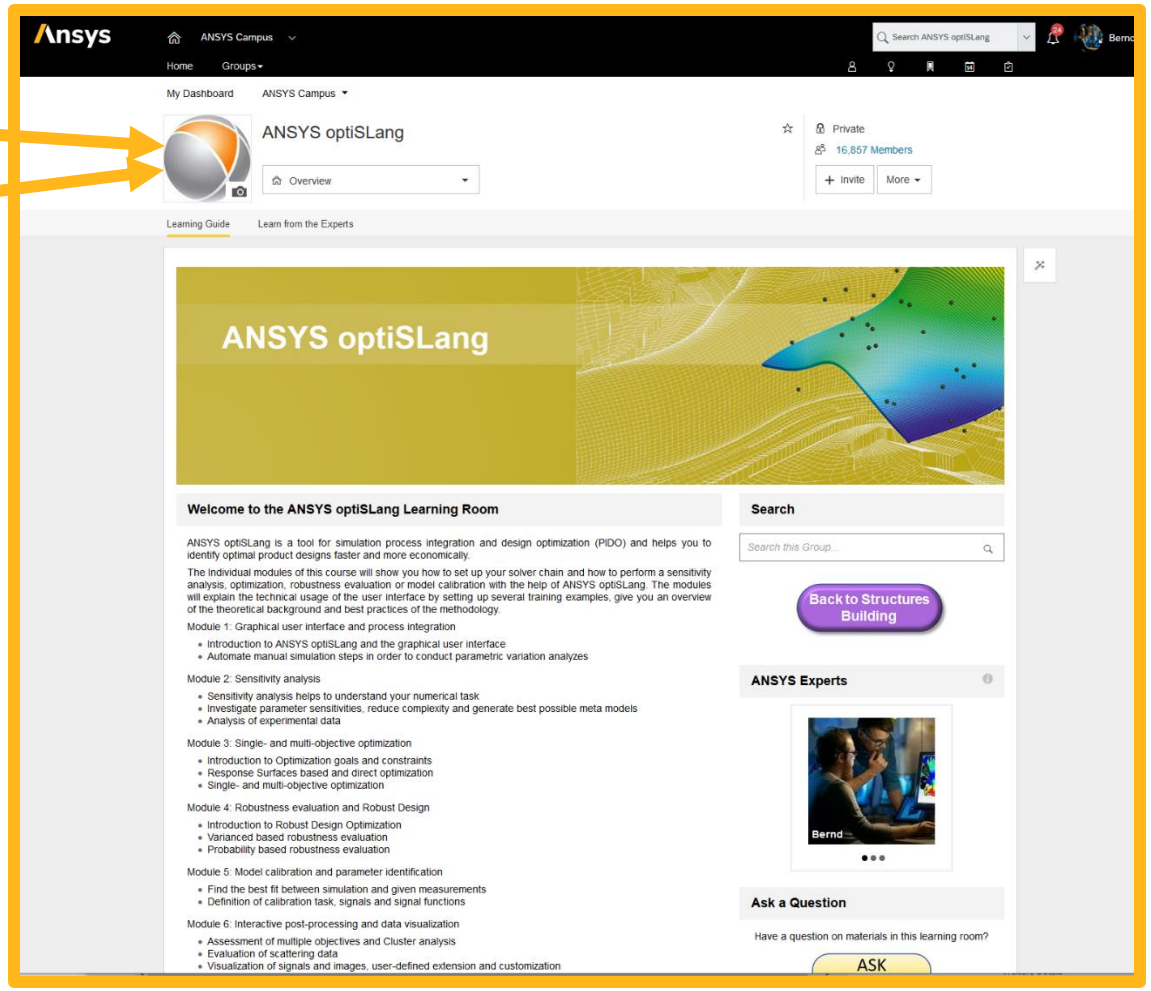
Some outlook

- New NOA
  - From beta
- MOP settings
  - Defaults and convenience
- AMOP
  - Multiobjective
- Datamining node
  - Wizard based filter definition
- Flatten the curve
  - Performance with many designs
- Postprocessing
  - Direct import from CSV
  - Framework for web-based Postprocessing
- Responsesurface Excel-Addin
  - Synergies with DesignXplorer development
- Integrations
  - E.g. Spaceclaim
- GUI
  - More flexibility to reset/restart designs

Summary, Q&A

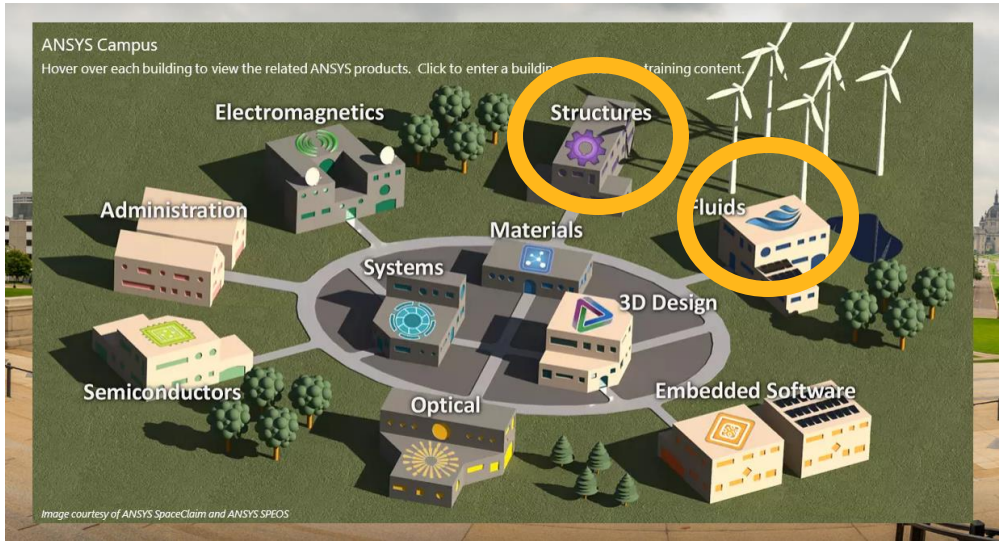
optiSLang inside Ansys Learning Hub

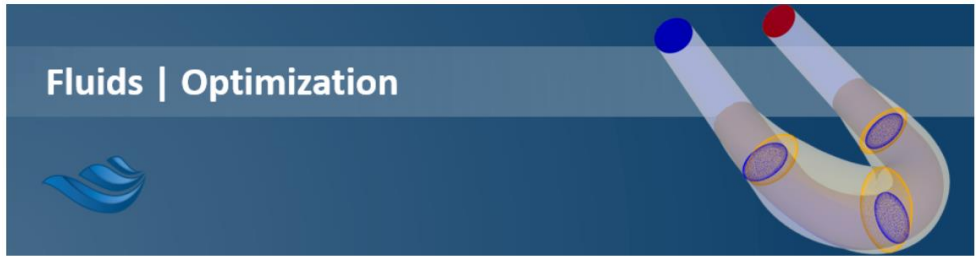




- optiSLang Rooms are available for **Structures** and **Fluids**
  - Corresponding examples can be found there
  - Examples to **Electro-Magnetic-Applications** are in the learn-from-Expert section in Structures Building
- Coming soon:
  - Optics, Electro-Magnetics
  - Platform Building

ANSYS Learning Hub





Welcome to the Ansys Fluids | Optimization Learning Room

Search

Welcome to the Structures Building

All learning starts with Structures | Getting started where you will receive the fundamental training on the ANSYS Mechanical product and associated complementary tools.

- If you are looking to browse courses of similar content, go to **Curriculum by Subject Matter**.
- If you want to know the relevant courses by Engineering role, go to **Curriculum by Role**.
- If you know the course you want to take, go to **Curriculum by Course Index**.

Core Concepts for Everyone

Advanced Practices | Mechanical APDL | Customization | Optimization

and/or structures undergoing large deformation and often material failure.

Materials Engineer

Studies the linear and nonlinear behavior of structures made from advanced materials such as plastics, rubbers, and composites and/or the post yield behavior of metallic structures.

Offshore Engineer

Evaluates the behavior of structures that operate in an ocean environment where hydrodynamic loads are of importance.

Structures Engineer

Evaluates the steady response of structures under static loading

optiSLang in buidings:

- Structures
- Fluids

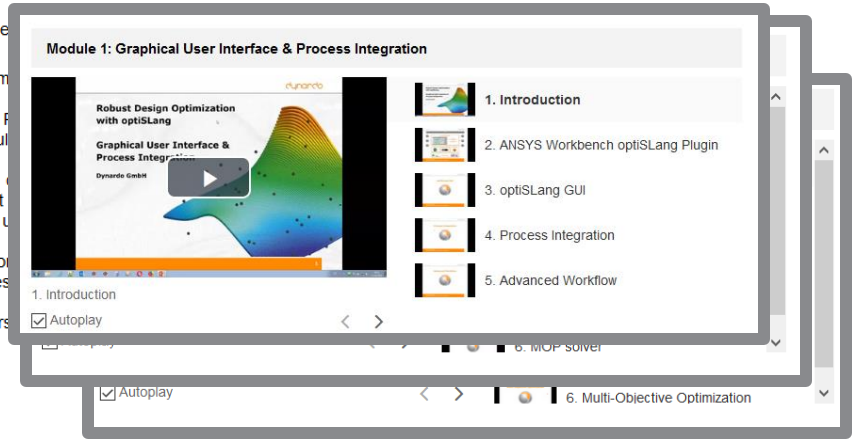
Next:

- **Platform**
- Electromagnetics
- Optics
- …

Platform

Ansys optiSLang (CFD)

- Process Integration: How can I automatize my Solve standalone or inside Workbench with optiSLang?
- Sensitivity analysis: Which Parameters are driving m the possible optimization potential of these?
- Multidisciplinary optimization: How can I find this shows the best design, even in cases with mul constraints?
- Robustness evaluation: How does the scattering input parameters effect the performance of the best
- Reliability analysis: Is my Design suitable to be u environment?
- Robust Design Optimization: Is there a way to auto and robustness to find the best possible robust des space?
- Parameter identification: Which Material parameters to match the behavior I saw in my last experiment?



Thank you for your attention!

- **More Case Studies?** Please, visit our Library: https://www.dynardo.de/en/library.html
- **More Question?** Please, contact Dynardo Support: dynardo_support@ansys.com
- **More Training?** Please, join the ALH: https://www.ansys.com/services/learning-hub
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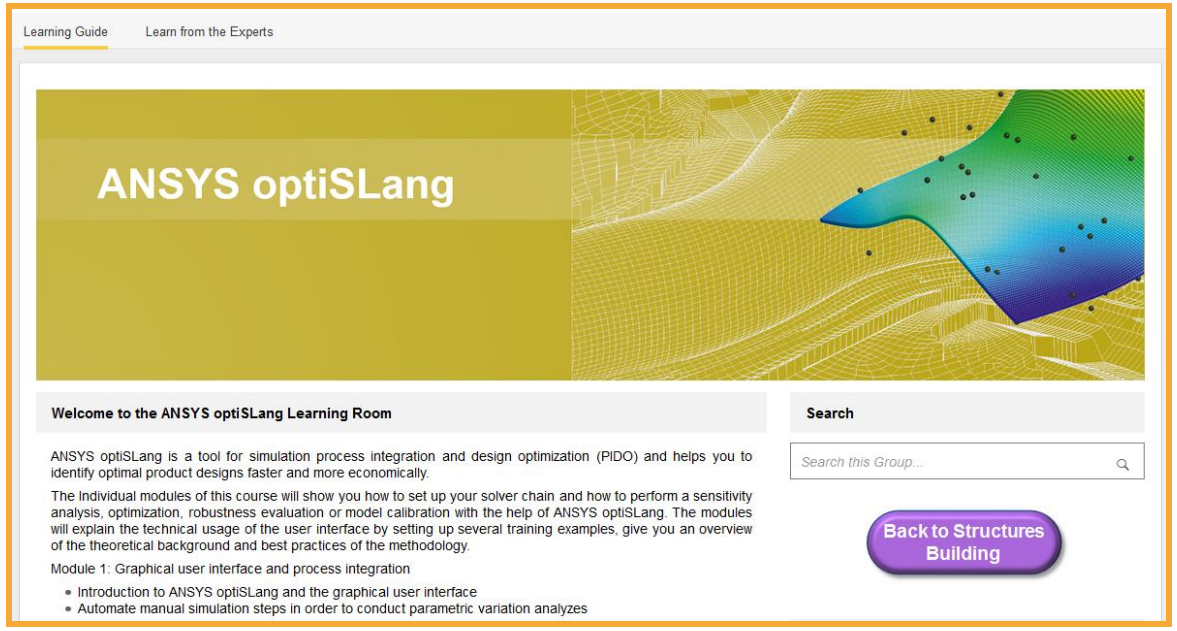


- Dynardo GmbH, an Ansys Company
- Steubenstr. 25
- 99423 Weimar
- www.dynardo.de

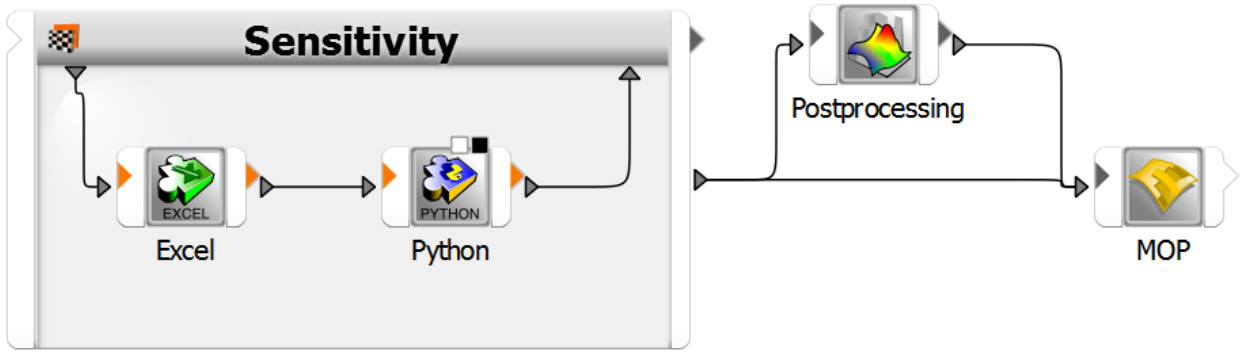
Join our optiSLang e-learning

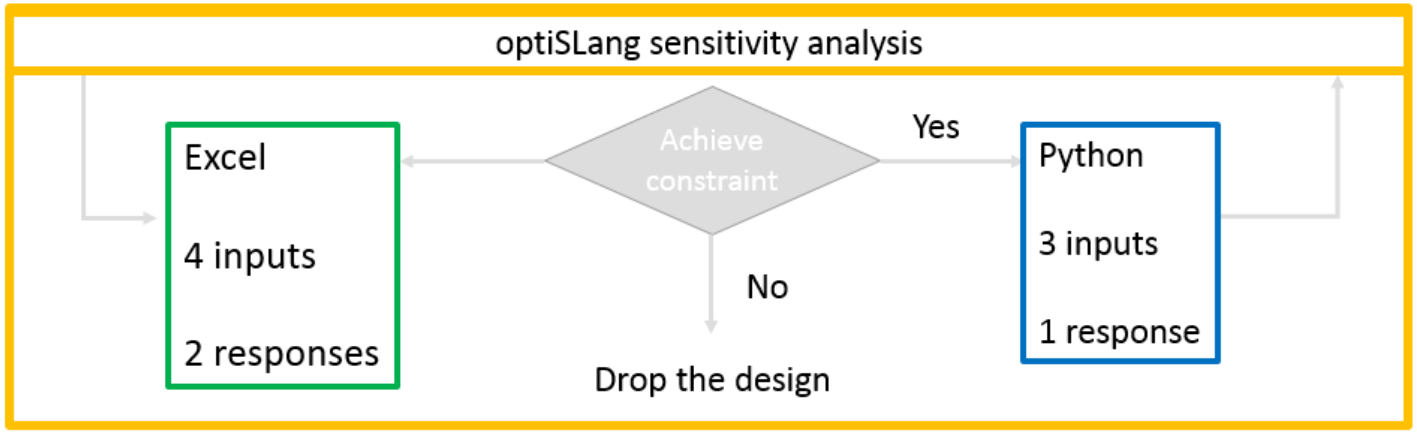
Unit	date
1 – Graphical user interface and process integration	30.06.2020
2 – Sensitivity analysis	01.07.2020
3 – Single- and multi-objective optimization	02.07.2020
4 – Robustness evaluation and Robust Design	07.07.2020
5 – Model calibration and parameter identification	08.07.2020
6 – Interactive post-processing and data visualization	09.07.2020
7 – optiSLang and Ansys Workbench	14.07.2020
8 – optiSLang and Ansys Electronics Desktop (AEDT)	15.07.2020

Participation is free of charge for ALH participants, register here : http://www.cvent.com/d/77qnr4/4W
Agenda : https://www.dynardo.de/de/getting-started/e-learning/optislang-e-learning.html

„Connect Algorithms“

- Classic MOP workflow (validation)
- Peter slides
- Daniel K. slide weiterleiten von designs
- Adas workflows

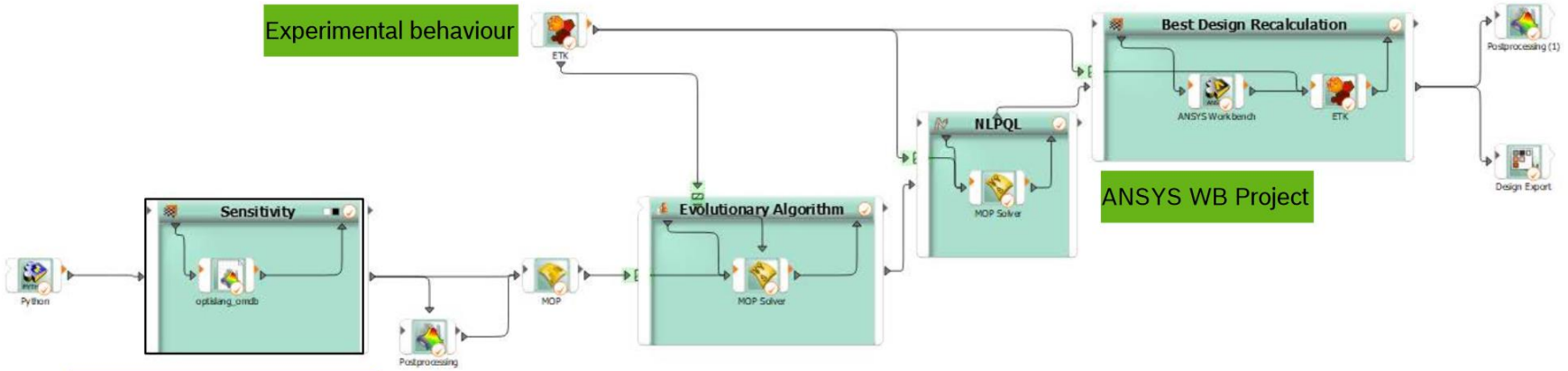




DEMOCRATIZATION OF CAE-WORKFLOWS WITH OPTISLANG AT BOSCH

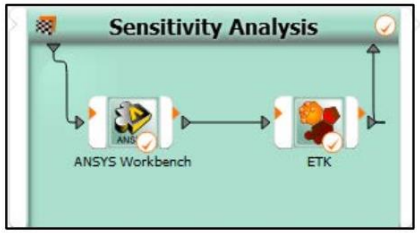
Democratization of CAE-workflows
Example: Component Model Updating

Experimental behaviour



ANSYS WB Project

Result of Sensitivity Analysis



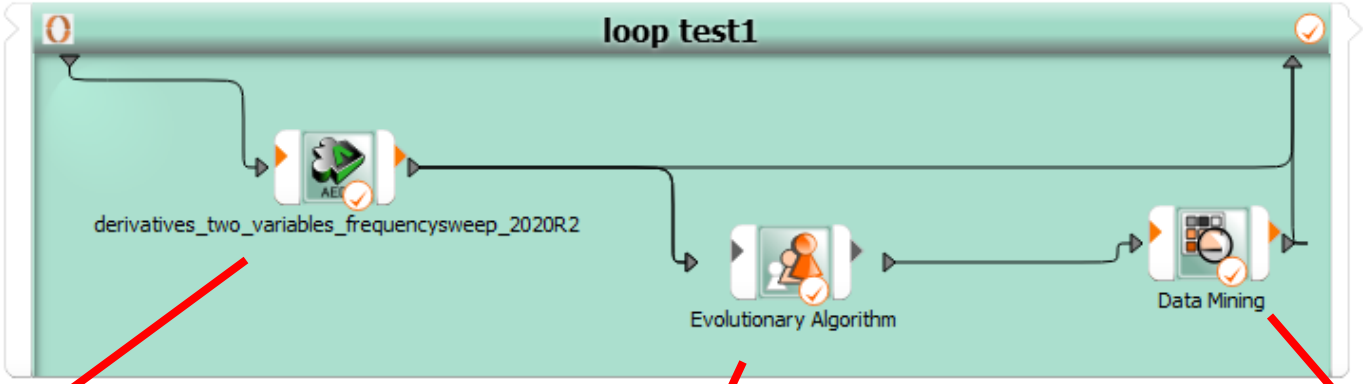
Setup of optiSLang project

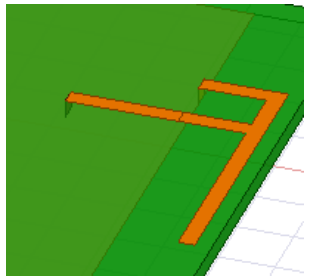
- optiSLang setup for the optimization of material (and geometry) parameters based on existing Sensitivity Analysis (to reduce test times)

Placeholders and Registered files

- Definition of registered files + placeholders to be provided by user interface

Automation with optiSLang

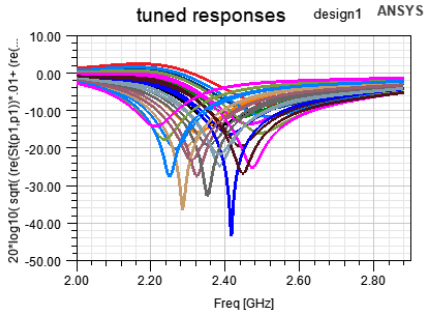




HFSS simulation output:
S-parameters and partial derivatives

$$S_{tuned} = S_{nominal} + \Delta S_{L1} + \Delta S_{L2}$$

Create equation for S_{tuned} based on partial derivatives



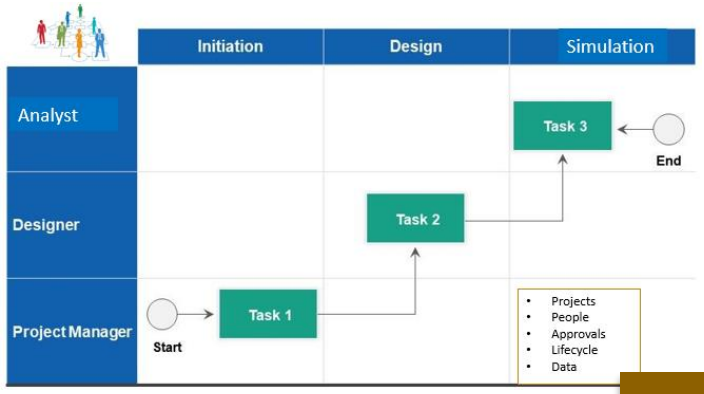
Optimization algorithm evaluates S_{tuned} for many variations of $L1_{tuned}$ and $L2_{tuned}$
Goal: $|S_{tuned}|$ is minimized at 2.44 GHz

What was the best predicted outcome of S_{tuned}?
Send $L1_{tuned}$ and $L2_{tuned}$ to HFSS to update nominal design

High level capabilities

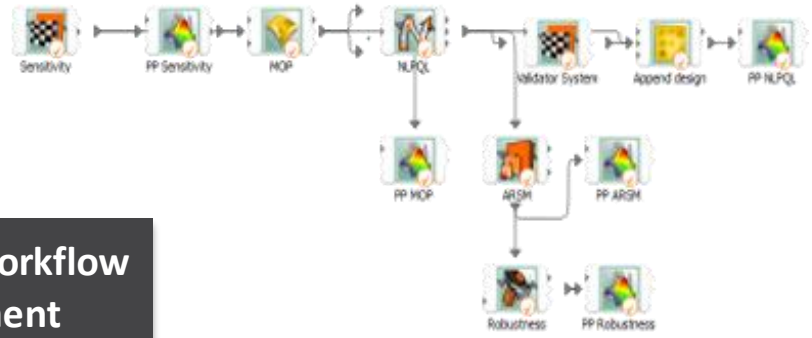
Ansys / MINERVA

Collaboration focused



Ansys / OPTISLANG

Automation focused



Business Process Management

Simulation Workflow Management

Data Management

Optimization and Robust Design

Interoperability with PLM, ALM..

Design of Experiments

Hybrid HPC

Tool Chaining and process Automation

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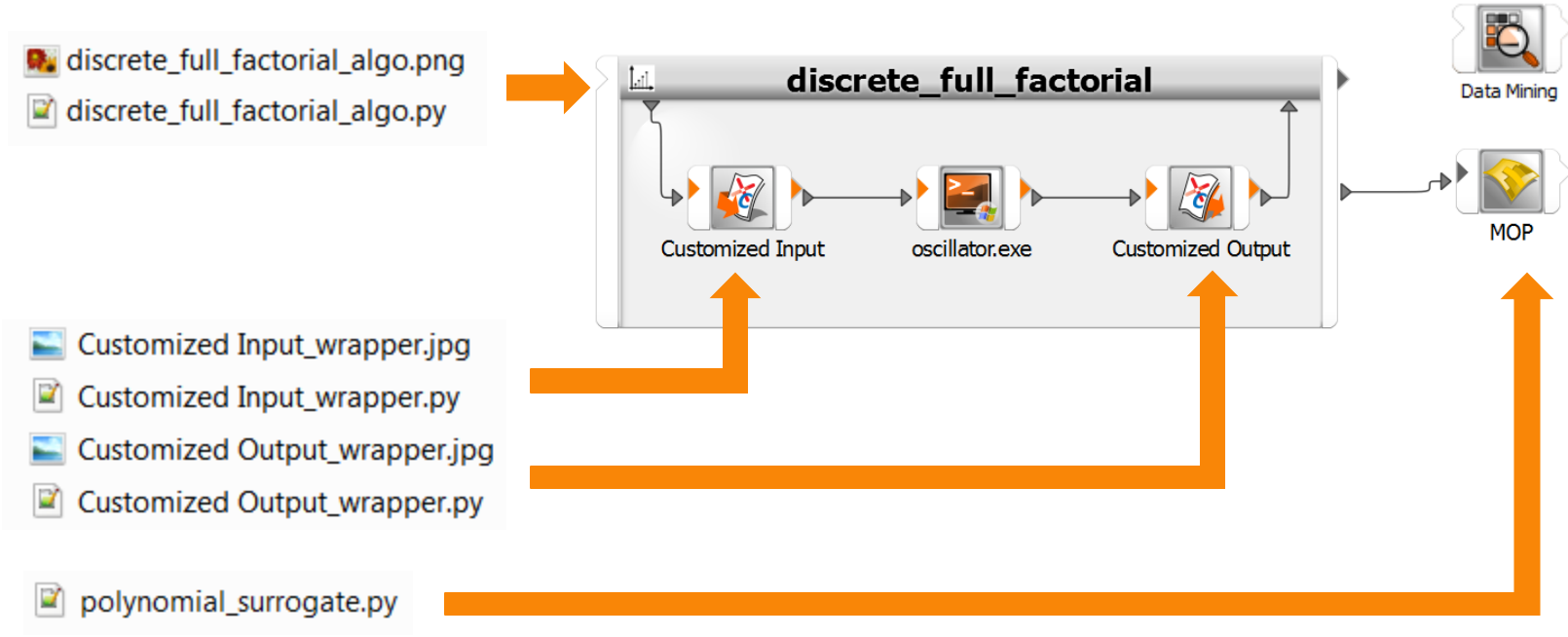
Customization overview

- optiSLang provides plugin mechanisms via Python scripting
  - Define own integration nodes
  - Implement own algorithms
  - Customize Solver Wizard and Postprocessing
  - Extend MOP algorithm with own surrogates (beta)
  - Implement Data Mining functions




Ansys