PyOWA @ Rheinmetall - The contribution of customization in leveraging web-based engineering tools

June 24th, 2022

WOST workshop| Artur Hottmann, Jessica Tamasi

Ansys WOST WORKSHOP

PASSION FOR TECHNOLOGY.

RHEINMETALL

Rheinmetall – **Five divisions under one roof**

VEHICLE SYSTEMS

Tactical Vehicles · Logistic Vehicles · Turrets · CBRN* Solutions

WEAPON AND AMMUNITION

Weapon and Munition · Protection Systems · Propulsion Systems

ELECTRONIC SOLUTIONS

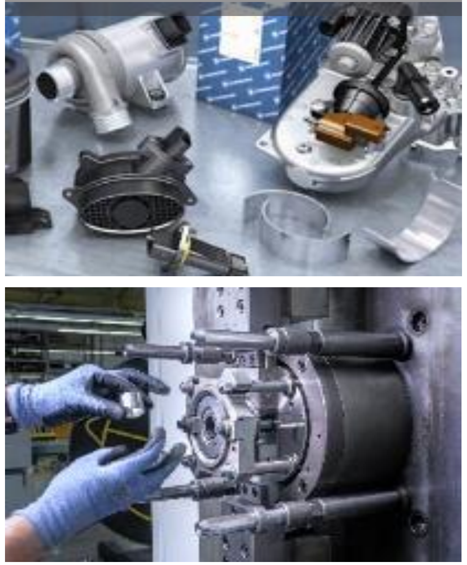
Integrated Electronic Systems · Air Defence and Radar Systems · Technical Publications · Cyber Security

SENSORS AND ACTUATORS

Pumps · Actuators · Air Emission Systems · Solenoid Valves · Commercial Diesel Systems

MATERIALS AND TRADE

Trade · Bearings · Castings (50:50 Joint Venture)



*Chemical, Biological, Radiological and Nuclear

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02 About contribution of customization

03 Rheinmetall PyOWA web app overview & app examples

04 Summary

Acknowledgement to **ANSYS DYNARDO Team** for first class support.

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Motivation & background

Coming from Rheinmetall presentation at WOST 2020…

KOLBENSCHMIDT

PIERBURG

MOTORSERVICE

About how the Power of Variance Analysis conquered Rheinmetall Automotive

Headquarter Research & Technology / Z-FB – Development Services

Z-FBC, Jessica Tamasi

17th WOST (virtual Conference) / June 26, 2020

OUR HEART BEATS FOR YOUR ENGINE.

RHEINMETALL AUTOMOTIVE

„Keep on growing internationally with optiSLang usage & **launch RHA optiSLang web-interface**.“

Remember also organizational context of simulation department Z-FBC…

= Internal simulation service supplier for division „Sensors and Actuators“ development teams.

= Diverse simulation tasks for various Rheinmetall products.

→ Different level of workflow complexity, workflow standardization and automatability.

→ High level competency and system understanding regarding products (i.e. due to using optiSLang).

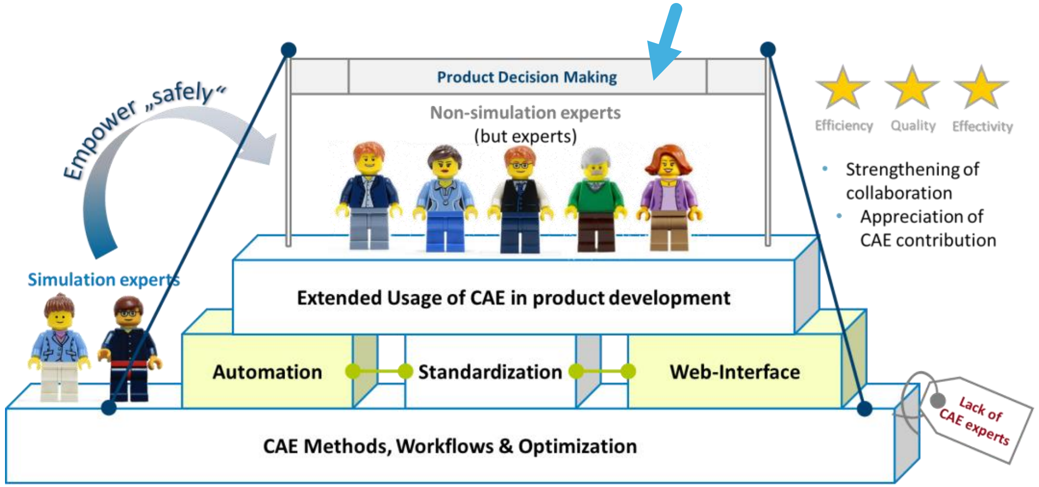
Still challenging to enforce frontloading in development projects ☹.

Help is at hand:

RHA optiSLang web-interface as essential part of CAE-Democratization

- Share knowledge & models.
- Enable simulation for non-simulation experts in development teams.
- Provide state-of-the-art methods & tools for i.e. data analysis.

Focus on web-interface users!



- Strengthening of collaboration
- Appreciation of CAE contribution

This illustration is inspired by Bosch presentation @ WOST 2019

Lego Characters: www.brick-shop.de

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Excursion into psychology

Aspects influencing web-app design and customization

Psychology offers valuable insights towards user needs.

Users are only human.

Fundamentals of human perception, cognition and behavior.

- from evolution: endogenous mechanisms that protect humans from having to constantly take care of all kinds of things → limited capabilities
- aversion to technology is mainstream → creatures of habit
- theory of customer satisfaction (Kano Model)
- …

www.creaturesofhabit.me

Nevertheless,

we would like to see those

creatures of habit using our apps

because it‘s beneficial in project!

They **are able to put simulation upfront!**

What do we learn from it regarding UX design?

Accept limitations. Expect them from users.

Adapt to user behavior (& needs) as UX designer.

Realize “Human-centered design”.

- Most important: web-apps have to be useful for user.
- Focus on avoiding nasty situations while using web-app.
- Provide a good first impression.
- Simple design, clarity & intuitivity.

→ **Minimize burden of adaptation to innovation for user.**

→ **“Stop designing [web-]experiences for us, for the “interactive 1%”.”**

Sources:

Epstein, M., UX For Brains: Eight ways psychology can improve your design, August 9, 2016, www.lullabot.com

Norman, D. et al., User Centered System Design: New Perspectives on Human-computer Interaction (1986)

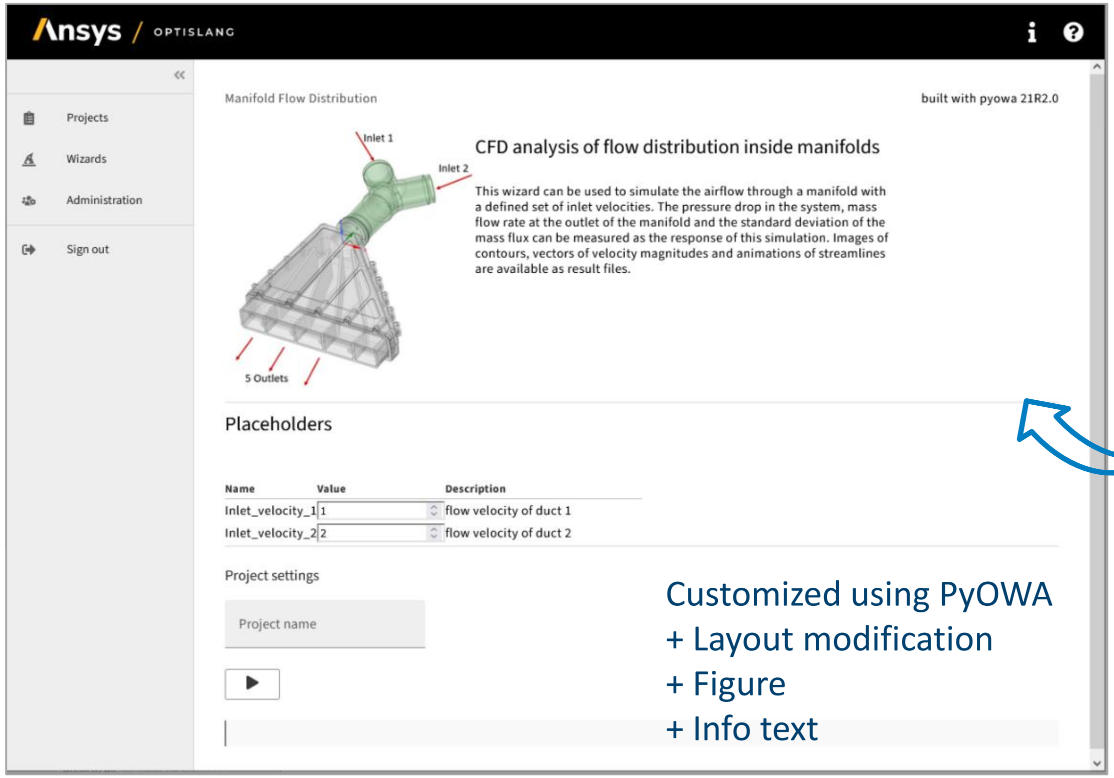
Weddehage J., Psychologie im UX-Design: alles Routine?, August 30, 2016, www.entwickler.de

Necessity of app customization
PyOWA library

__Py__thon based __O__ptiSLang __W__eb __A__pplication (PyOWA)
Python module that allows creation of customized UI for optiSLang web apps using python code.

PyOWA "Auto-generate app" – functionality available. Not sufficient to fulfill user needs.

WOST 2021 „industrial track C", example „Manifold flow distribution"



Manifold Flow Distribution

built with pyowa 21R2.0

CFD analysis of flow distribution inside manifolds

This wizard can be used to simulate the airflow through a manifold with a defined set of inlet velocities. The pressure drop in the system, mass flow rate at the outlet of the manifold and the standard deviation of the mass flux can be measured as the response of this simulation. Images of contours, vectors of velocity magnitudes and animations of streamlines are available as result files.

Placeholders

Name	Value	Description
Inlet_velocity_1	1	flow velocity of duct 1
Inlet_velocity_2	2	flow velocity of duct 2

Project settings

Project name

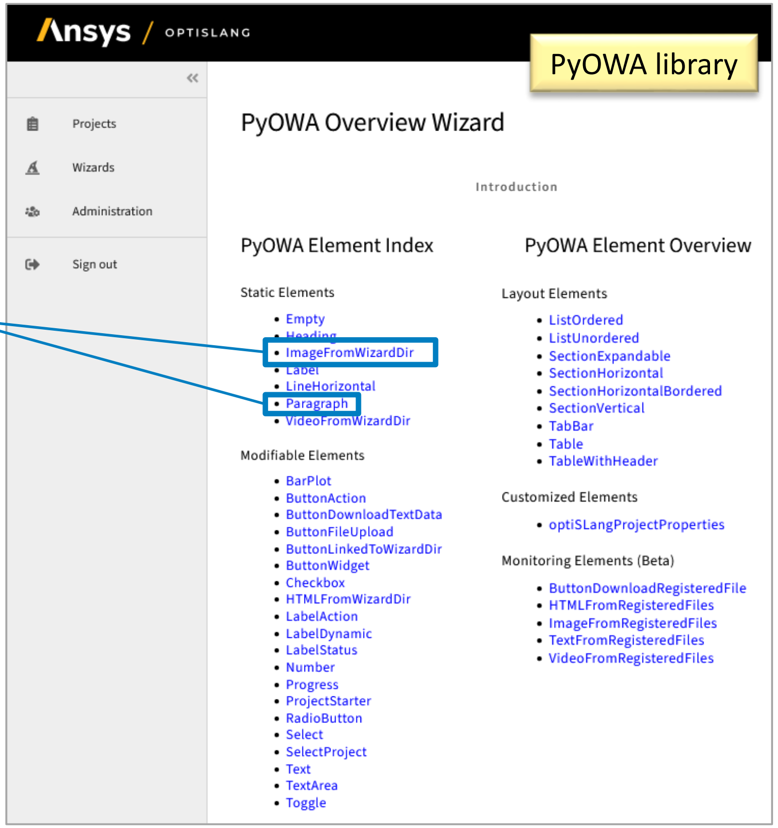
Customized using PyOWA
+ Layout modification
+ Figure
+ Info text

So let's go and add some lines of python code:

```
# load_wizard.py

pyowa.ImageFromWizardDir('manifold.png')

pyowa.Paragraph("This wizard can be used
                to simulate the
                airflow…")
```



PyOWA Overview Wizard

Introduction

PyOWA Element Index

Static Elements

- Empty
- Heading
- ImageFromWizardDir
- Label
- LineHorizontal
- Paragraph
- VideoFromWizardDir

Modifiable Elements

- BarPlot
- ButtonAction
- ButtonDownloadTextData
- ButtonFileUpload
- ButtonLinkedToWizardDir
- ButtonWidget
- Checkbox
- HTMLFromWizardDir
- LabelAction
- LabelDynamic
- LabelStatus
- Number
- Progress
- ProjectStarter
- RadioButton
- Select
- SelectProject
- Text
- TextArea
- Toggle

PyOWA Element Overview

Layout Elements

- ListOrdered
- ListUnordered
- SectionExpandable
- SectionHorizontal
- SectionHorizontalBordered
- SectionVertical
- TabBar
- Table
- TableWithHeader

Customized Elements

- optiSLangProjectProperties

Monitoring Elements (Beta)

- ButtonDownloadRegisteredFile
- HTMLFromRegisteredFiles
- ImageFromRegisteredFiles
- TextFromRegisteredFiles
- VideoFromRegisteredFiles

Necessity of app customization

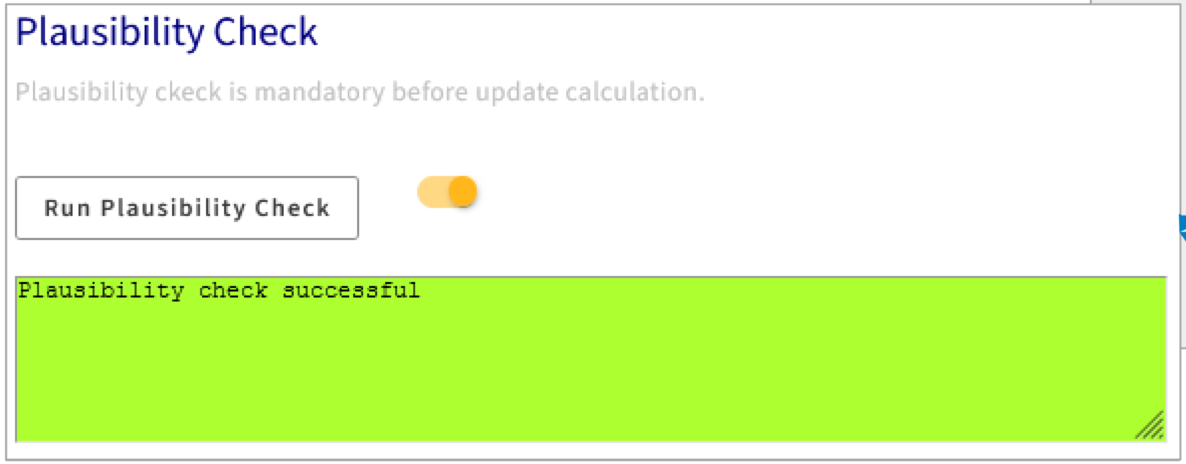
PyOWA library

***Py**thon based **O**ptiSLang **W**eb **A**pplication (PyOWA)*
Python module that allows creation of customized UI for optiSLang web apps using python code.

PyOWA "Auto-generate app" – functionality available. Not sufficient to fulfill user needs.

Why Plausibility Check?

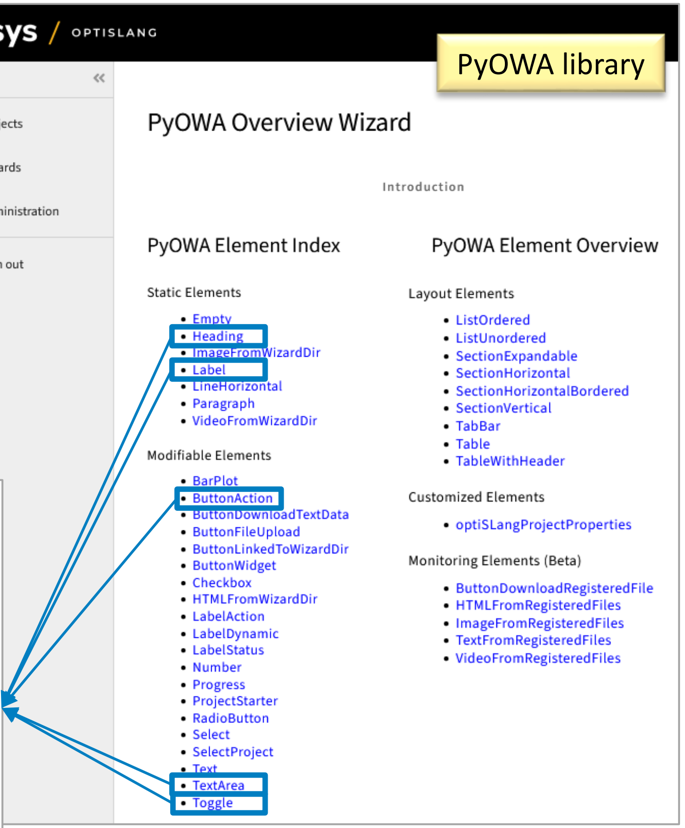
- Lock project starter until user input is plausible.
- Avoid project failure due to wrong user input.
- Provide feedback for user and chance to adjust input.



Plausibility Check

Plausibility ckeck is mandatory before update calculation.

```
Plausibility check successful
```



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Implementation of design rules & functionalities with PyOWA library for a "smooth" user experience. Example: RH Plausibility Check.

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Rheinmetall PyOWA web app overview

3 app categories

Initial situation @ Rheinmetall

Several engineering tools of different categories available as executables, excel tools etc. widely spread in the company.

Mission

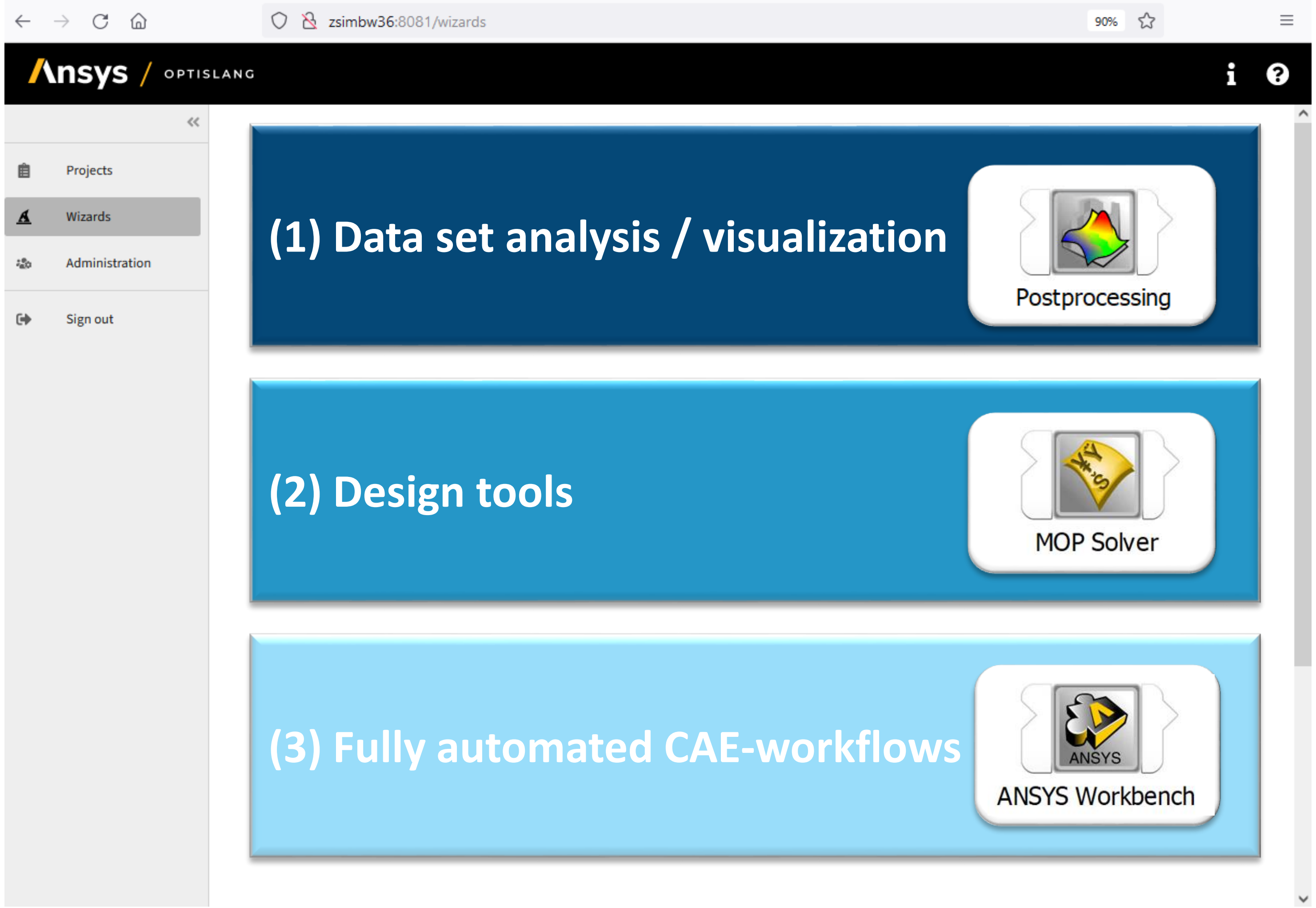
Shift all tools to web service.

Advantages of central platform

- Library view for tools (→ „get inspired“).
- No local installation of software (i.e. version update with less effort).
- Simplified maintenance & bug fix.
- Live user notification.

Further Features

- User/licence management
- Similar „look & feel“ in tools/apps.



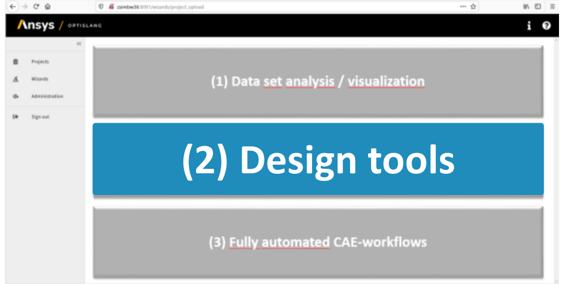
(1) Data set analysis / visualization

(2) Design tools

(3) Fully automated CAE-workflows

Rheinmetall MOP solver app example

EGR path investigation (GT Power) - Basic PyOWA Template



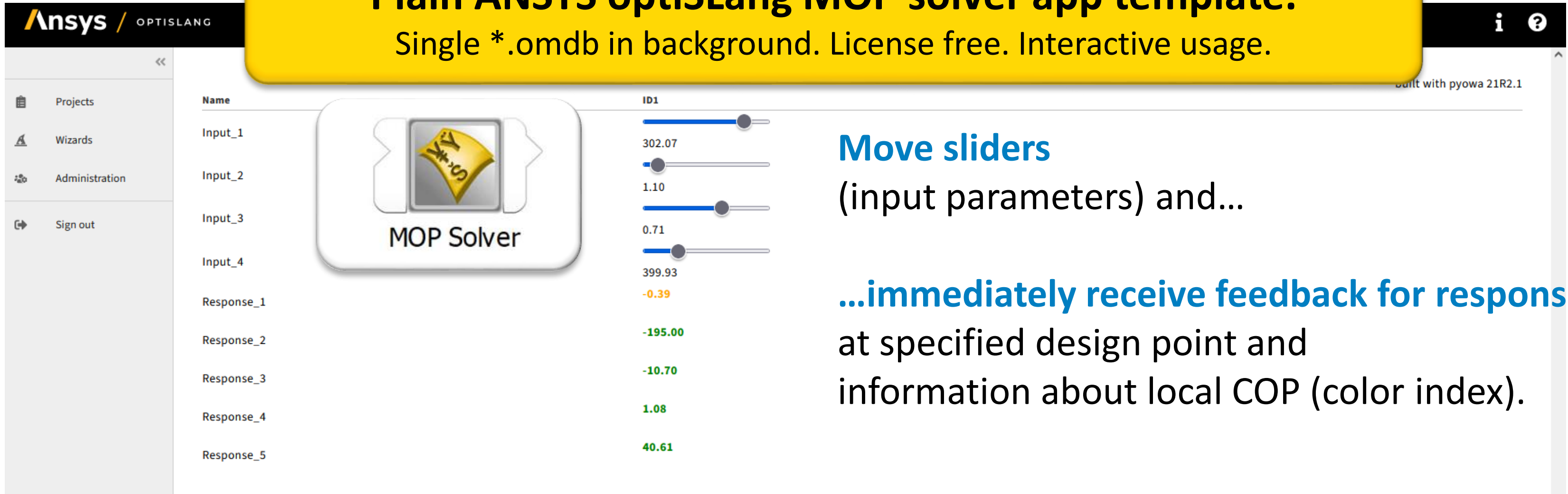
Ansys / OPTISLANG

(1) Data set analysis / visualization

(2) Design tools

(3) Fully automated CAE-workflows

Plain ANSYS optiSLang MOP solver app template.
Single *.omdb in background. License free. Interactive usage.



Ansys / OPTISLANG

- Projects
- Wizards
- Administration
- Sign out

MOP Solver

uilt with pyowa 21R2.1

Name	ID1
Input_1	302.07
Input_2	1.10
Input_3	0.71
Input_4	399.93
Response_1	-0.39
Response_2	-195.00
Response_3	-10.70
Response_4	1.08
Response_5	40.61

Move sliders
(input parameters) and…

…immediately receive feedback for responses
at specified design point and
information about local COP (color index).

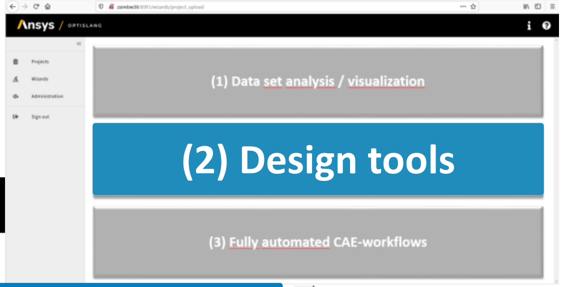
Information protection

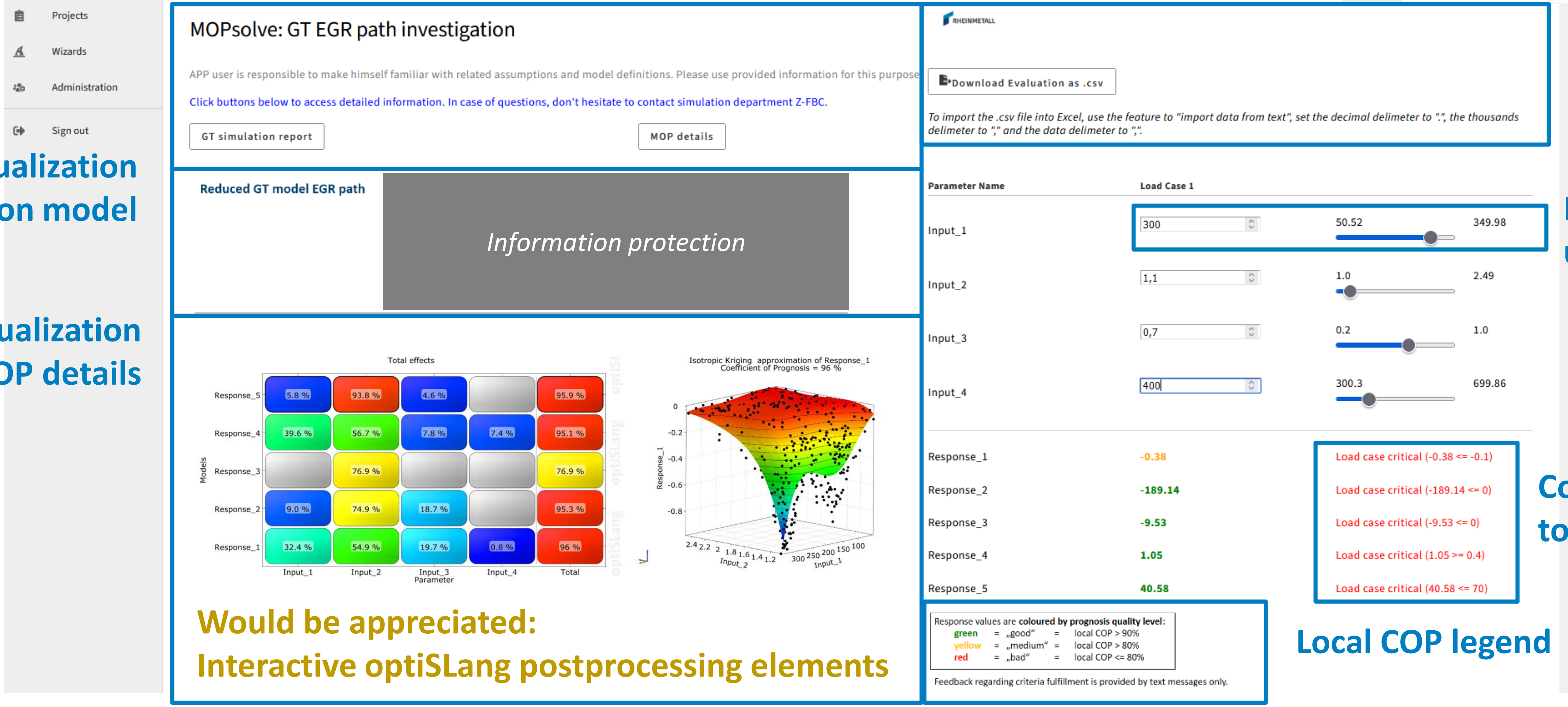
Very nice ☺ – but possible problems for app-user:

- Missing project context.
- Imprecise design point specification (only slider).
- Inconvenient arrangement „slider ↔ value info“.
- No visual separation (input vs. output).
- …

Rheinmetall MOP solver app example

EGR path investigation (GT Power) – Enhanced PyOWA Template


Ansys / OPTISLANG
Projects
Wizards
Administration
Sign out
(1) Data set analysis / visualization
(2) Design tools
(3) Fully automated CAE-workflows



Information section

MOPsolve: GT EGR path investigation

APP user is responsible to make himself familiar with related assumptions and model definitions. Please use provided information for this purpose

Click buttons below to access detailed information. In case of questions, don't hesitate to contact simulation department Z-FBC.

GT simulation report | MOP details

Visualization simulation model

Reduced GT model EGR path

Information protection

Visualization MOP details

Would be appreciated:
Interactive optiSLang postprocessing elements

Download results

RHEINMETALL

Download Evaluation as .csv

To import the .csv file into Excel, use the feature to "import data from text", set the decimal delimeter to ".", the thousands delimeter to "," and the data delimeter to ",".

Enhanced user input

Parameter Name	Load Case 1		
Input_1	300	50.52	349.98
Input_2	1,1	1.0	2.49
Input_3	0,7	0.2	1.0
Input_4	400	300.3	699.86
Response_1	-0.38	Load case critical (-0.38 <= -0.1)	
Response_2	-189.14	Load case critical (-189.14 <= 0)	
Response_3	-9.53	Load case critical (-9.53 <= 0)	
Response_4	1.05	Load case critical (1.05 >= 0.4)	
Response_5	40.58	Load case critical (40.58 <= 70)	

Comparison to criteria

Response values are **coloured by prognosis quality level:**

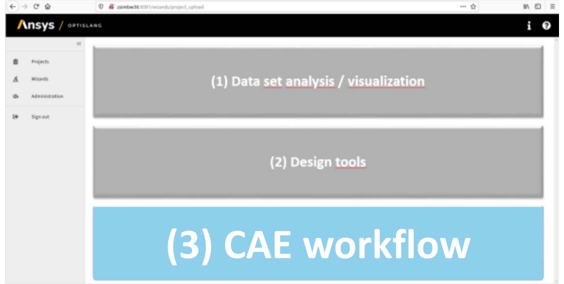
green	=	„good"	=	local COP > 90%
yellow	=	„medium"	=	local COP > 80%
red	=	„bad"	=	local COP <= 80%

Feedback regarding criteria fulfillment is provided by text messages only.

Local COP legend

Automated CAE workflow app example

C4D – CFD for Designers

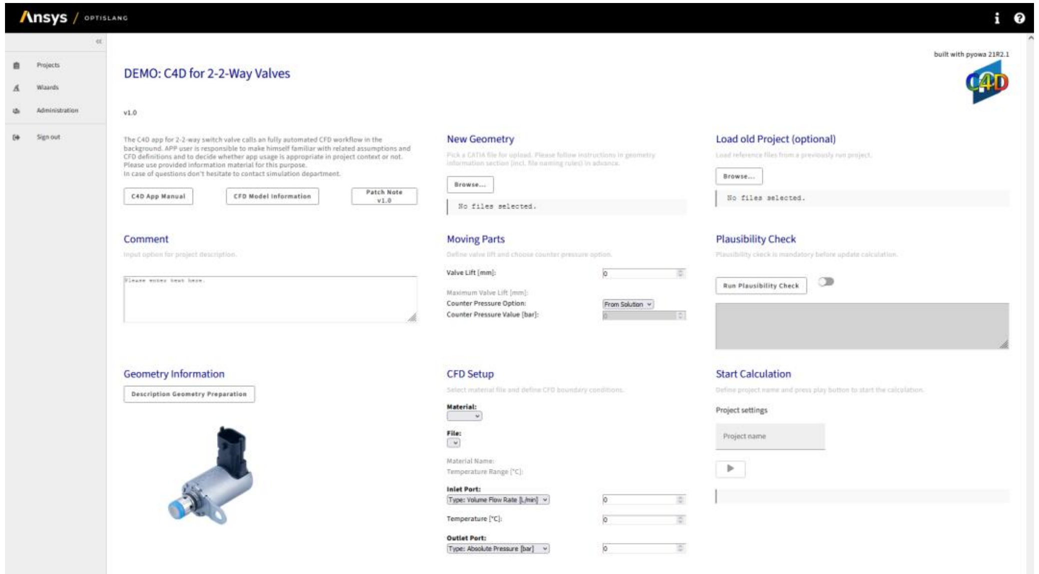


(1) Data set analysis / visualization

(2) Design tools

(3) CAE workflow

Goal: Profit from early CFD simulation in development projects (= frontloading).
How? Enable designers to perform CFD simulation.
Measure: Development of the C4D tool → ready 2017 (*.exe) → **Improved within PyOWA app since 2022**



DEMO: C4D for 2-2-Way Valves

v1.0

The C4D app for 2-2-way switch valve calls an fully automated CFD workflow in the background. APP user is responsible to make himself familiar with related assumptions and CFD definitions and to decide whether app usage is appropriate in project context or not. Please use provided information material for this purpose.
In case of questions don't hesitate to contact simulation department.

C4D App Manual | CFD Model Information | Patch Note v1.0

Comment

Input option for project description.

Please enter text here.

Geometry Information

Description Geometry Preparation

New Geometry

Pick a CATIA file for upload. Please follow instructions in geometry information section (incl. file naming rules) in advance.

Browse...

No files selected.

Moving Parts

Define valve lift and choose counter pressure option.

Valve Lift [mm]: 0

Maximum Valve Lift [mm]:
Counter Pressure Option: From Solution
Counter Pressure Value [bar]: 0

CFD Setup

Select material file and define CFD boundary conditions.

Material:

File:

Material Name:
Temperature Range [°C]:

Inlet Port:
Type: Volume Flow Rate [L/min] 0

Temperature [°C]: 0

Outlet Port:
Type: Absolute Pressure [bar] 0

Load old Project (optional)

Load reference files from a previously run project.

Browse...

No files selected.

Plausibility Check

Plausibility check is mandatory before update calculation.

Run Plausibility Check

Start Calculation

Define project name and press play button to start the calculation.

Project settings

Project name

▶

High level of abstraction "inside"

- Flow volume with moving part.
- 1 inlet, 1 outlet.

Powerful process control "inside"

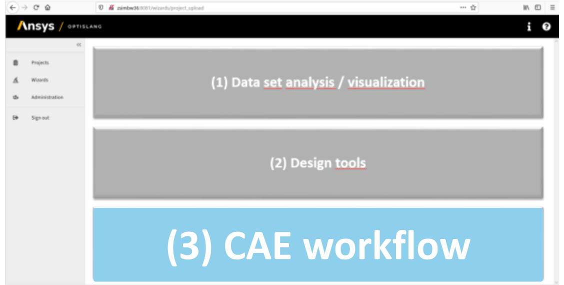
- Automatic detection of relevant CAD faces (for boundary condition definition).
- Robust, automatic meshing.
- Convergence supervision.
- Standard postprocessing.

→ Applicable for designers in diverse projects for different products.

→ Same "backbone" as CFD jobs worked in central simulation department.

Automated CAE workflow app example

Migration of former GUI layout to new app experience


(1) Data set analysis / visualization

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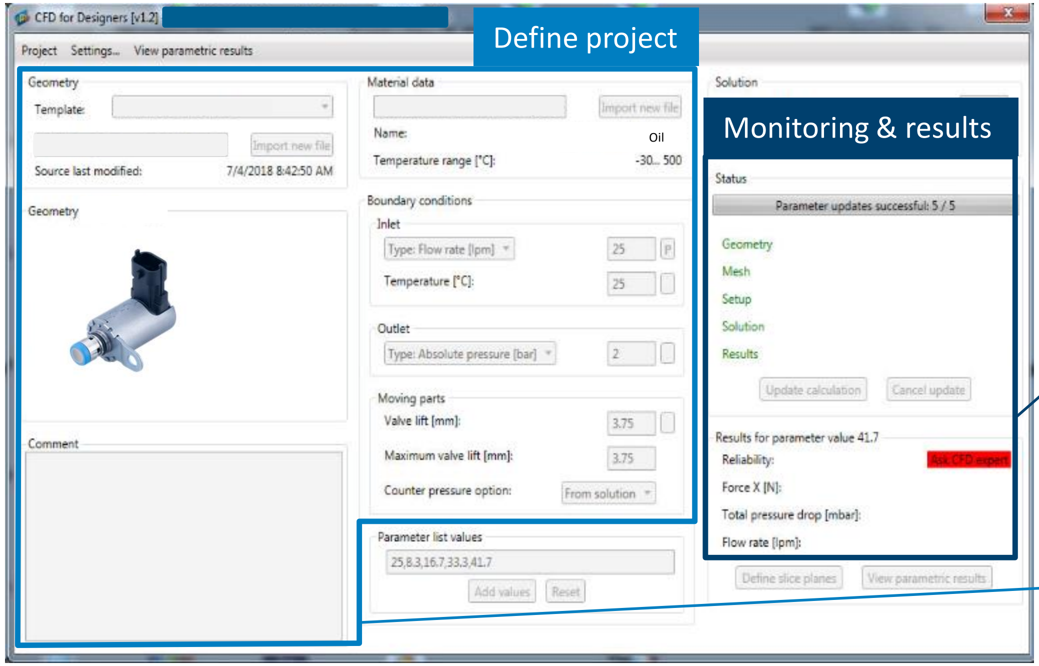
Remember: minimize burden of adaptation for user.

Improvements in layout & usability.
Only small changes.
Unavoidable @ PyOWA: split into wizard & monitoring page.



Geometry

Template:

Source last modified: 7/4/2018 8:42:50 AM

Geometry

Comment

Material data

Name: Oil

Temperature range [°C]: -30... 500

Boundary conditions

Inlet

Type: Flow rate [lpm] 25

Temperature [°C]: 25

Outlet

Type: Absolute pressure [bar] 2

Moving parts

Valve lift [mm]: 3.75

Maximum valve lift [mm]: 3.75

Counter pressure option: From solution

Parameter list values

25,8.3,16.7,33.3,41.7

Solution

Status

Parameter updates successful: 5 / 5

Geometry
Mesh
Setup
Solution
Results

Results for parameter value 41.7

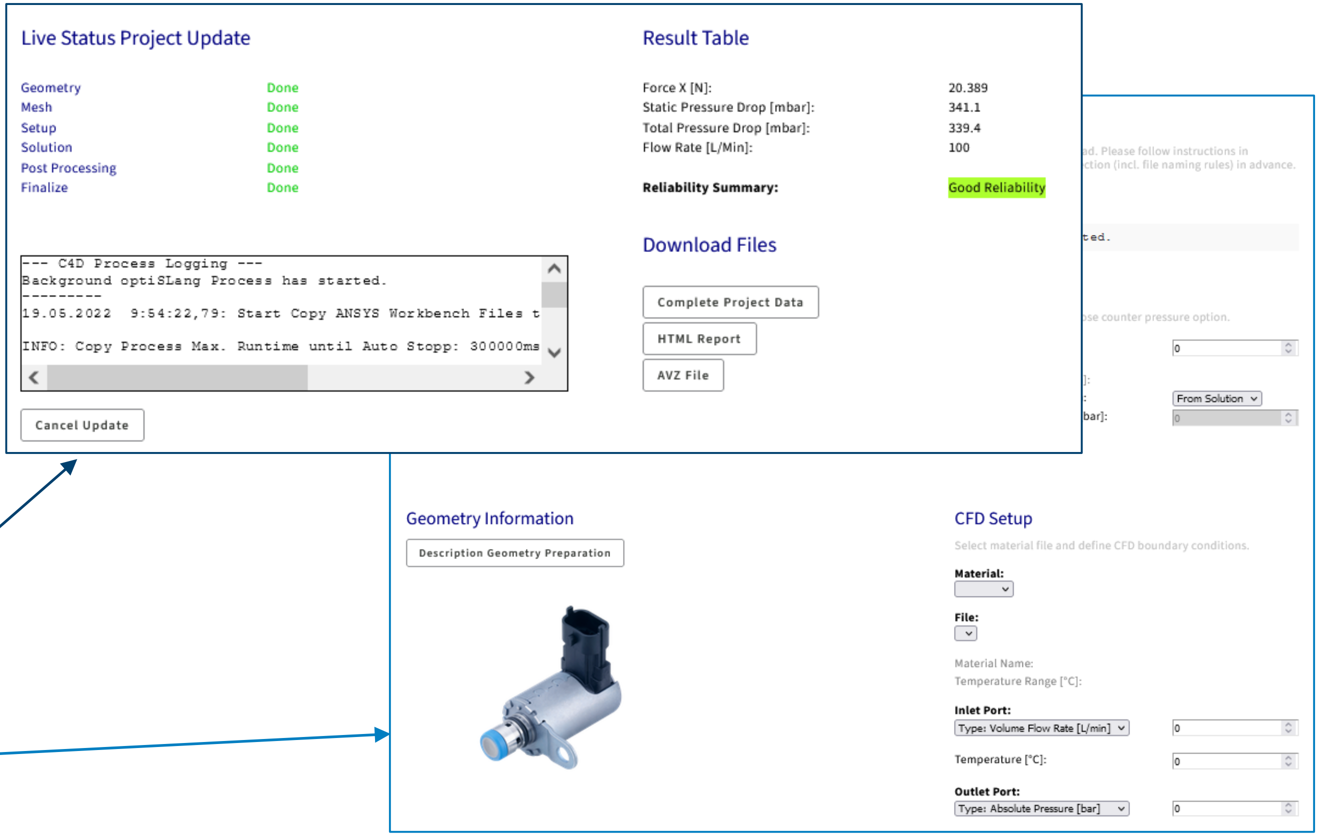
Reliability: Ask CFD expert

Force X [N]:

Total pressure drop [mbar]:

Flow rate [lpm]:

Excerpt of monitoring page



Live Status Project Update

Geometry	Done
Mesh	Done
Setup	Done
Solution	Done
Post Processing	Done
Finalize	Done

```
--- C4D Process Logging ---
Background optiSLang Process has started.
---------
19.05.2022  9:54:22,79: Start Copy ANSYS Workbench Files t

INFO: Copy Process Max. Runtime until Auto Stopp: 300000ms
```

Result Table

Force X [N]:	20.389
Static Pressure Drop [mbar]:	341.1
Total Pressure Drop [mbar]:	339.4
Flow Rate [L/Min]:	100
Reliability Summary:	Good Reliability

Download Files

ad. Please follow instructions in
ction (incl. file naming rules) in advance.

ted.

ose counter pressure option.

0

From Solution

bar]: 0

Geometry Information

CFD Setup

Select material file and define CFD boundary conditions.

Material:

File:

Material Name:

Temperature Range [°C]:

Inlet Port:

Type: Volume Flow Rate [L/min] 0

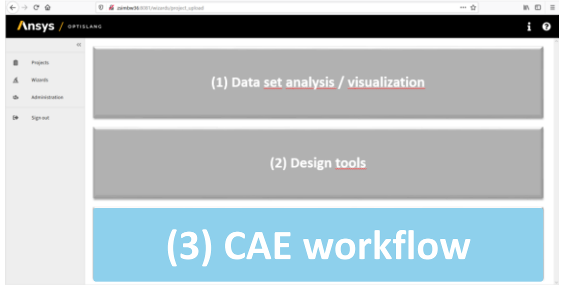
Temperature [°C]: 0

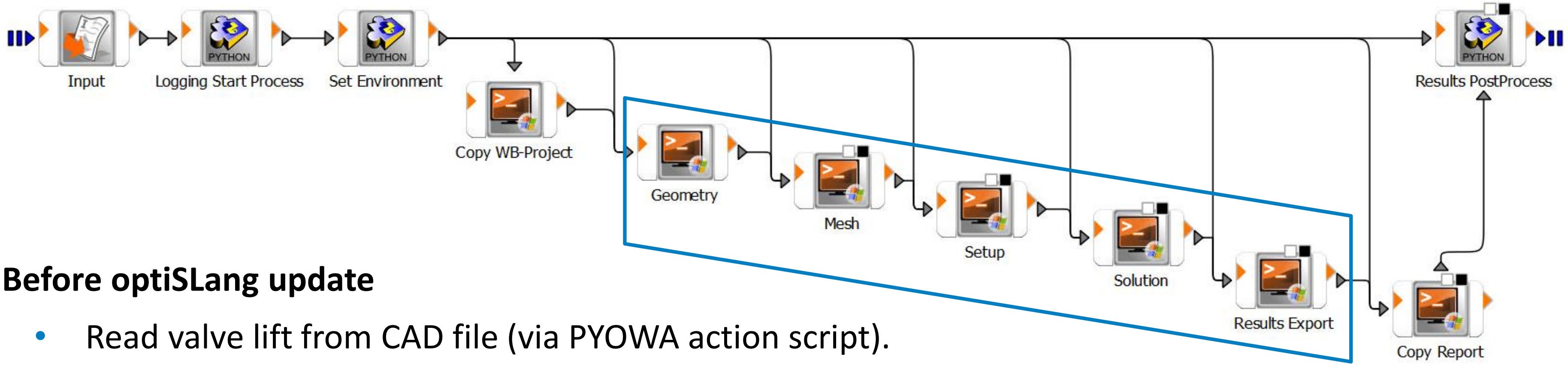
Outlet Port:

Type: Absolute Pressure [bar] 0

Automated CAE workflow app example

optiSLang process





Before optiSLang update

- Read valve lift from CAD file (via PYOWA action script).
- Process user input from frontend (= optiSLang parameters) & environment setup (= optiSLang placeholders) in run_project.py.

Coupling with ANSYS Workbench

- Text-based parameter exchange.
- Start workbench via batch node (+ *.wbjn) → "step-by-step"

After optiSLang update

- Send back response values (= optiSLang placeholders)
- Provide result images (= optiSLang registered files)

Additional optiSLang tasks as process master

- Manage error handling
- Provide status monitoring & logging towards frontend
- Organize data & files
- …

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Summary & Conclusion

- optiSLang webinterface successfully launched at Rheinmetall.
- Significant contribution to leverage simulation-driven design and frontloading.
- Using PyOWA tool box for implementation of design rules & functionalities → "smooth" user experience.

Mission: Extend Rheinmetall PyOWA apps by transfer of existing tools & development of further innovative apps @ all three categories.

(1) data set visualization

(2) design tools

(3) automated CAE workflows

Lessons learned during PyOWA app development

- Keep app users in focus – How do they behave? What are their needs…
- Requires collaboration of experts (programming, optiSLang, CAE workflow).
- Investments in Rheinmetall PyOWA template development pays off: i.e. significant speed-up in app release.

Potential for improvements in PyOWA universe = need for more functionality

- User guidance/limitation/assistance – i.e. improved locking options, pop-up help elements, …
- MOP visualization, optiSLang postprocessing elements @ custom monitoring page, …

PyOWA outlook @ Rheinmetall

Keep on growing while working app order queue.

PASSION FOR **TECHNOLOGY.**

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