

# PAE Model Bank – User Guide

The application provides saved models within itself which the user can select for further exploration

It contains 5 functionalities that is Model Introduction, Model and Data Import, Visualization, Simulation and Optimisation

**Model Introduction:** Provides the name of the model along with its owner and information about the model selected

**Model and Data Import:** Enables user to see the equations that are saved within a given model and allows user to manually simulate a model or import a dataset to view the results of simulation.

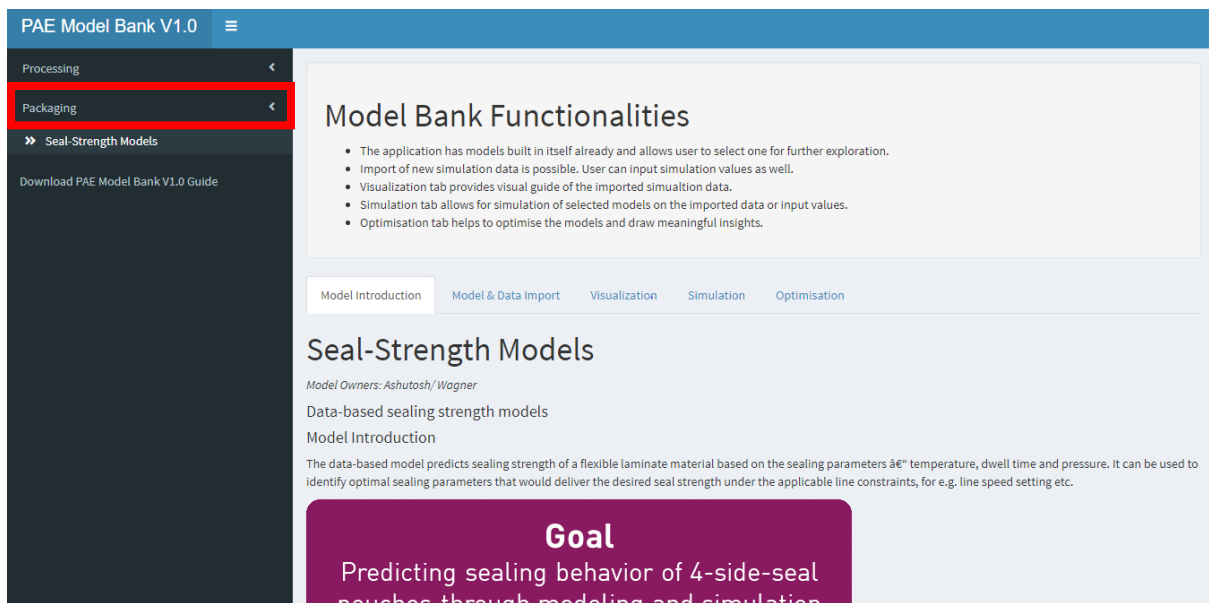
**Visualization:** Provides univariate, Bivariate and Multivariate analysis of the dataset that is imported

**Simulation:** This tab is split into two manual entry and import data simulation respectively. The manual entry simulation reflects outcome of the input values for simulation in the Model and data import page whereas the Import data simulation shows the predictions based on the dataset that is previously imported.

**Optimisation:** This tab enables user to optimize the selected equation based on constraints defined and the lower and upper limits of the predictor variables.

## 1- Model Introduction

Select “Packaging” in the Sidebar panel to further explore packaging models



Model Introduction
Model & Data Import
Visualization
Simulation
Optimisation

## Seal-Strength Models

Model Owners: Ashutosh/ Wagner




Data-based sealing strength models

Model Introduction

The data-based model predicts sealing strength of a flexible laminate material based on the sealing parameters – temperature, dwell time and pressure. It can be used to identify optimal sealing parameters that would deliver the desired seal strength under the applicable line constraints, for e.g. line speed setting etc.

### Goal

Predicting sealing behavior of 4-side-seal pouches through modeling and simulation

- Model introduction provides the information about the model along with its owner.

## 2 -Model and Data Import:

Model Introduction
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## Available Model Outputs

- This table presents the available model for this segment.
- Simulation will take place for all equations simultaneously.

Show  entries

Search:

	Models
1	$\text{Mean\_Seal\_Strength}(\text{monoPP\_Haiti}) = (10.085043285) + (0.143476202) * ((\text{Sealing\_Pressure} - 50) / 25)) + (0.5005544208) * ((\text{Sealing\_Time} - 475) / 275) + (1.1487322096) * ((\text{Sealing\_Temperature} - 120) / 20) - (0.265927563) * ((\text{Layer\_Thickness} - 35) / 5) - (0.214751072) * ((\text{Sealing\_Pressure} - 50) / 25) * ((\text{Sealing\_Time} - 475) / 275) + (0.1653191326) * ((\text{Sealing\_Pressure} - 50) / 25) * ((\text{Layer\_Thickness} - 35) / 5) - (0.190088312) * ((\text{Sealing\_Time} - 475) / 275) * ((\text{Layer\_Thickness} - 35) / 5) - (0.227255444) * ((\text{Layer\_Thickness} - 35) / 5) * ((\text{Sealing\_Temperature} - 120) / 20) - (0.438383433) * ((\text{Sealing\_Pressure} - 50) / 25) * ((\text{Sealing\_Pressure} - 50) / 25) + (0.422789614) * ((\text{Sealing\_Time} - 475) / 275) * ((\text{Sealing\_Time} - 475) / 275)$
2	$\text{Mean\_Seal\_Strength}(\text{Paper\_metOPP/70-100gsmPaper\_18metOPP}) = (7.9283468534) - (1.744214002) * ((\text{Layer\_Thickness} - 85) / 15) + (2.0472868262) * ((\text{Sealing\_Temperature} - 180) / 60) + (1.0299432676) * ((\text{Sealing\_Time} - 475) / 275) + (1.0456231626) * ((\text{Sealing\_Temperature} - 180) / 60) * ((\text{Sealing\_Time} - 475) / 275) - (0.085441804) * ((\text{Sealing\_Pressure} - 77) / 38.5)$
3	$\text{Mean\_Seal\_Strength}(\text{Paper\_metOPP/90gsmPaper\_15-18metOPP}) = (7.5004364288) + (2.1104133638) * ((\text{Sealing\_Temperature} - 180) / 60) + (0.9519562501) * ((\text{Sealing\_Time} - 475) / 275) + (1.0656214205) * ((\text{Sealing\_Temperature} - 180) / 60) * ((\text{Sealing\_Time} - 475) / 275) + (0.2754606935) * ((\text{Layer\_Thickness} - 16.5) / 1.5) - (0.007364972) * ((\text{Sealing\_Pressure} - 77) / 38.5)$
4	$\text{Mean\_Seal\_Strength}(\text{Paper\_metOPP/100gsmPaper\_18metOPP}) = (8.2995281922) + (4.1535657286) * ((\text{Sealing\_Temperature} - 180) / 60) + (0.9568895775) * ((\text{Sealing\_Time} - 475) / 275) - (3.199586193) * ((\text{Sealing\_Temperature} - 180) / 60) * ((\text{Sealing\_Temperature} - 180) / 60) + (0.7476644958) * ((\text{Sealing\_Temperature} - 180) / 60) * ((\text{Sealing\_Time} - 475) / 275) + (0.0536281149) * ((\text{Sealing\_Pressure} - 77) / 38.5)$

- Available model Outputs show the equations that are provided within the models.

## Manual Entry Simulation:

Within Simulation Data Inputs the user can pick manual entry simulation of external data import.

### Accepted range for user inputs

Showing 10 entries

Search:

	Ingredients	Lower_Level	Upper_Level
1	Sealing_Pressure	30	110
2	Sealing_Time	200	700
3	Sealing_Temperature	100	240
4	Layer_Thickness	15	100

Showing 1 to 4 of 4 entries

Previous 1 Next

- The above table shows the lower and upper limits for all the predictors

## Simulation Data Inputs

Only one of manual data entry and external import is allowed. Select one and proceed. In manual entry user needs to input variable values within the prescribed limits. And external import will allow user to bring in outside files for simulation.

Manual Entry External Data Import

- Following table is editable. Enter the simulation values.
- Entered values will automatically be saved for simulation stage.

### The table shows variables for Mean Seal Strength Prediction

Showing 10 entries

Search:

	Sealing_Pressure	Sealing_Time	Sealing_Temperature	Layer_Thickness
Enter Simulation Values	50	475	120	35

Showing 1 to 1 of 1 entries

Previous 1 Next

[Go to simulation](#)

- The red box shows that the selection is manual entry simulation
- This sub division enables the user to manually input various values of the predictor variables to see its corresponding response variable.
- The table in green is the input table where the values for various predictors need to be given by the user.
- If the predictor value falls outside the range, it will turn red.
- The user can move to the simulation page by clicking on the "Go to Simulation" button.

## External Data Import

### Simulation Data Inputs

Only one of manual data entry and external import is allowed. Select one and proceed. In manual entry user needs to input variable values within the prescribed limits. And external import will allow user to bring in outside files for simulation.

**Manual Entry** External Data Import

- This segment provides simulation data import functionality.
- A time series excel file dataset is expected with the naming format of variables in equation.

#### Import Simulation Data

Browse... 2021\_02\_modeling\_dataset\_single\_compilation.xlsx

Upload complete

Show 10 entries

Search:

	Pack_Format	Material_Name	Converter	Stack	Layer_1_outer	Layer_1_thickness_um	Layer_2	Layer_2_thickn
1	4-side-seal Pouch	Haiti Turkey	Mondi	3	BOPP	20	metallized OPP	
2	4-side-seal Pouch	Haiti Turkey	Mondi	3	BOPP	20	metallized OPP	
3	4-side-seal Pouch	Haiti Turkey	Mondi	3	BOPP	20	metallized OPP	
4	4-side-seal Pouch	Haiti Turkey	Mondi	3	BOPP	20	metallized OPP	

- The red box shows that the selection is External data simulation
- Once the dataset is successfully uploaded, we see the complete blue line and also the dataset imported is shown below.
- If there is a predictor missing in the dataset imported the app will show a pop up but will continue to simulation assuming the value of that predictor as 0.

## 2- Visualization

7	4-side-seal Pouch	Haiti Turkey	Mondi	3	BOPP	20	metallized OPP	
8	4-side-seal Pouch	Haiti Turkey	Mondi	3	BOPP	20	metallized OPP	
9	4-side-seal Pouch	Haiti Turkey	Mondi	3	BOPP	20	metallized OPP	
10	4-side-seal Pouch	Haiti Turkey	Mondi	3	BOPP	20	metallized OPP	

Showing 1 to 10 of 324 entries

Previous 1 2 3 4 5 ... 33 Next

Go to Visualization

- Once the dataset is imported, click on "Go to Visualization" to further explore the dataset.

### Visual guide for imported data.

- This tab presents visualizations of the externally imported data.
- First two graphs allow overlapping of two variables on Y axis.
- While the first graph presents linear trend through line graph, the second graph presents linear regression based trend in data.
- Third graph shows scatter plot as well as trend lines. Upto 4 variables are allowed in this graph on Y axis.
- Finally a histogram is presented.

## Scatter Plot

- This scatter graph allows for multiple Y axis selection on single x axis.
- Maximum 4 selections are allowed for Y axis. Linear regression method is used for creating trendlines.

### X axis

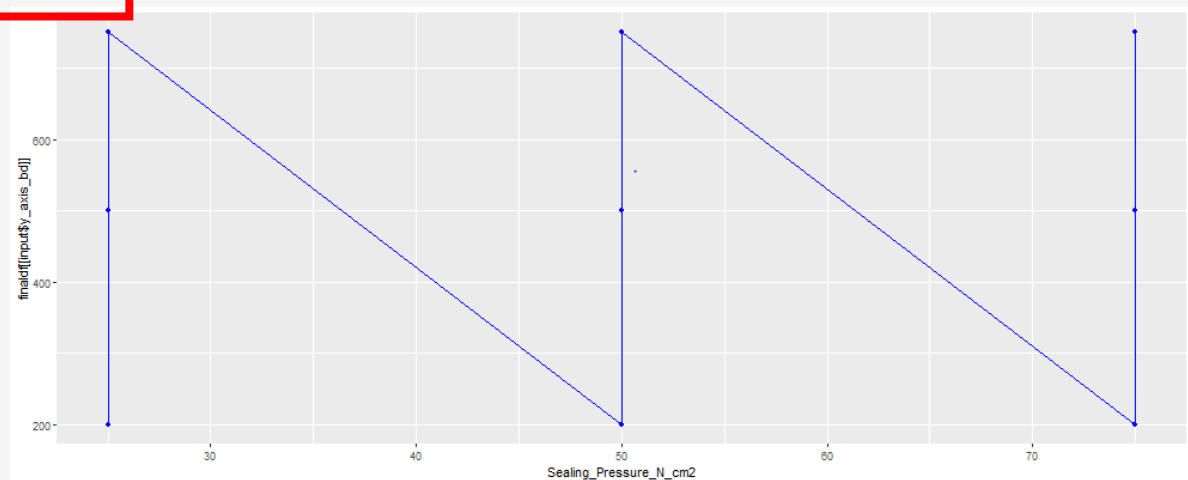
Sealing\_Pressure\_N\_cm2

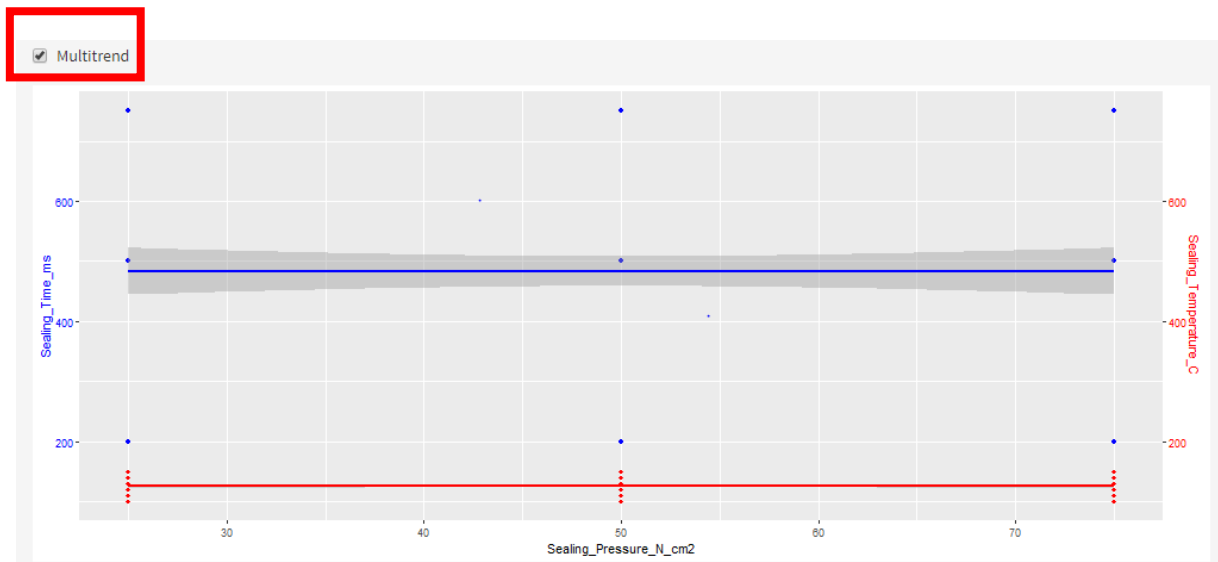
### Y axis

Sealing\_Time\_ms

- The above page appears after clicking the button.
- Select the desired X and Y variables from the drop down.
- Only 1 variable selection is allowed for X axis, whereas up to 4 can be selected for Y axis

☒ Trend Line

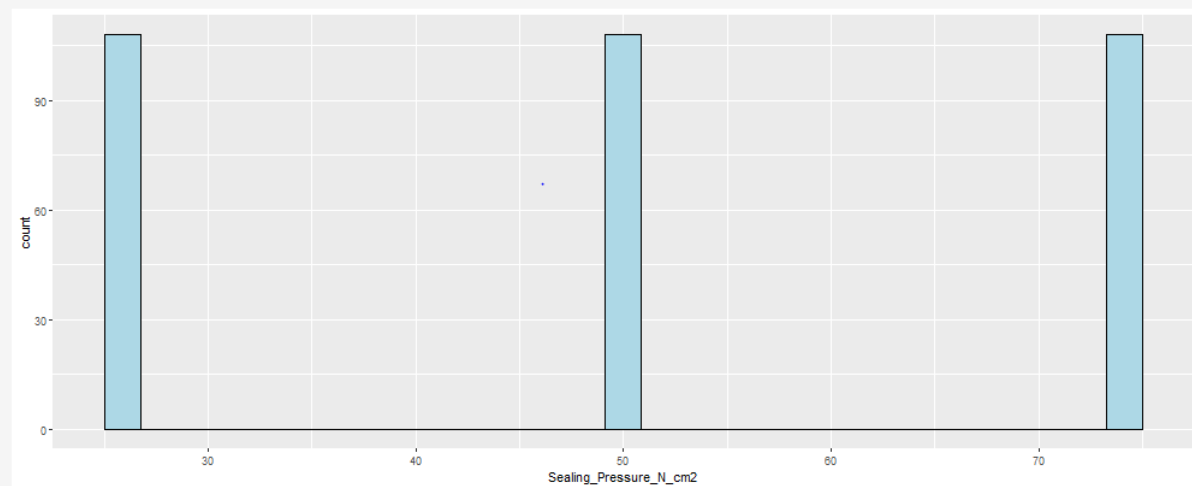




## Histogram

Histogram Variable

Sealing\_Pressure\_N\_cm2



- The first two graphs allow for double Y axis selection with single X axis selection.
- It takes the first two selection of the Y axis to plot linear regression of X against the respective Y
- Check boxes for trendline and multitrend line can be selected or unselected to view the trendline based on preference.
- The histogram at the end provides distribution of each variable which can be selected through the drop down

### 3- Simulation

The simulation page is split into 3 parts, Manual entry simulation, Profiler and Export data simulation

#### Manual Entry Simulation

Manual Entry simulation provides capability of simulating on input values (Provided and model and Data import Page)

The screenshot shows the 'Simulation' tab selected in the top navigation bar. Below it, the 'Simulation Input Response' section is highlighted with a red box. This section contains three sub-tabs: 'Manual Entry Simulation' (selected), 'Profiler', and 'Imported Data Simulation'. Below the sub-tabs, the heading 'Input values taken for manual simulation.' is followed by a 'Show 10 entries' dropdown and a search bar. A table displays input values for four predictors: Sealing\_Pressure, Sealing\_Time, Sealing\_Temperature, and Layer\_Thickness. The values are 50, 475, 120, and 35 respectively. Below the table, it says 'Showing 1 to 1 of 1 entries' with 'Previous' and 'Next' navigation buttons. At the bottom, there are two buttons: 'Simulate on entered Data' and 'Download above result'.

	Sealing_Pressure	Sealing_Time	Sealing_Temperature	Layer_Thickness
Enter Simulation Values	50	475	120	35

- The red box shows the selection of manual entry simulation
- The table “Input values taken for Manual Simulation” acts as a check to reconfirm the values of various predictors.
- Once the values are checked, click on “Simulation on entered data”
- The final table “Predicted values and their classification”/ “Predicted Values” show the results generated for the following inputs.

The screenshot shows the 'Simulation Results' section. It has a 'Show 10 entries' dropdown and a search bar. A table displays predicted values for four predictors: monoPP\_Haiti, Paper\_metOPP\_70\_100gsmPaper\_18metOPP, Paper\_metOPP\_90gsmPaper\_15\_18metOPP, and Paper\_metOPP\_100gsmPaper\_18metOPP. The values are 10.085, 11.755, and 8.793 respectively. Below the table, it says 'Showing 1 to 1 of 1 entries' with 'Previous' and 'Next' navigation buttons. At the bottom, there is a 'Download above result' button.

monoPP_Haiti	Paper_metOPP_70_100gsmPaper_18metOPP	Paper_metOPP_90gsmPaper_15_18metOPP	Paper_metOPP_100gsmPaper_18metOPP
10.085	11.755	8.793	

- “Download above results” saved the input values taken for manual simulation along with its output.

## Profiler

### Simulation Input Response

Manual Entry Simulation

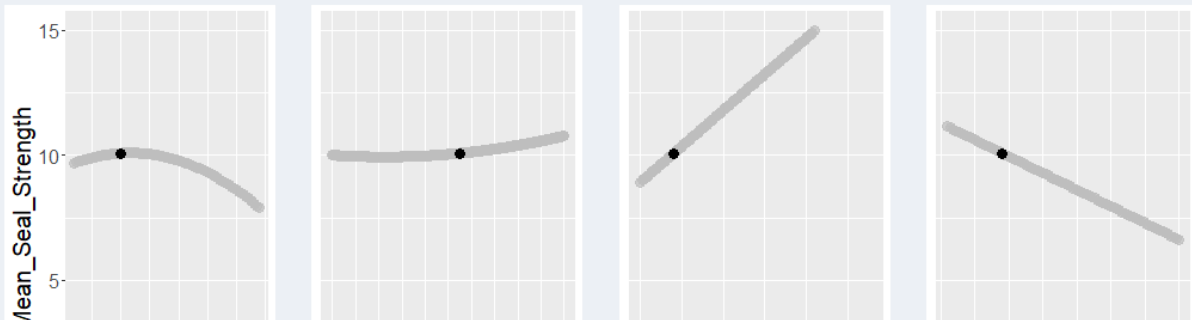
Profiler

Imported Data Simulation

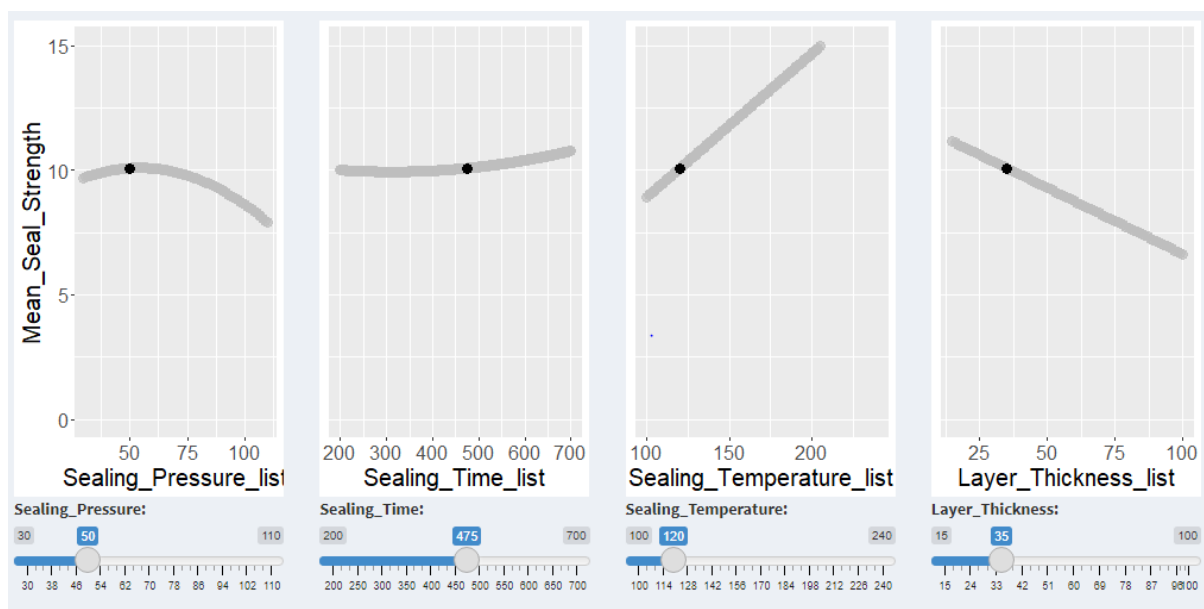
## Profiler

Select Packaging Model

monoPP\_Haiti



- The red box shows the selection as profiler
- The user can use the drop down to pick the equation that they want to work with
- The profiler allows user to scroll for various values of the predictors
- The graphs on top change as per the input changes in the scroller based for various response variable





## Import data simulation

[Model Introduction](#) [Model & Data Import](#) [Visualization](#) [Simulation](#) [Optimisation](#)

Simulation Input Response

[Manual Entry Simulation](#) [Profiler](#) [Imported Data Simulation](#)

Table only presents the results with condition of predicted Torque being in the range of 19 to 36.

[Simulate on Imported Data](#)

- After the dataset is imported in Model & Data Import Page
- Click on “Simulate on Imported Data” to see the values of response variables based on the dataset imported
- The red box shows the selection of import data simulation and the simulate button.

Once the button is pressed the results will be shown as following

Simulation Results

Show  entries Search:

monoPP_Haiti	Paper_metOPP_70_100gsmPaper_18metOPP	Paper_metOPP_90gsmPaper_15_18metOPP	Paper_metOPP_100gsmPaper_18metOPP
8.104	13.702		5.074
8.104	13.702		5.074
8.104	13.702		5.074
9.019	13.869		5.248
9.019	13.869		5.248
9.019	13.869		5.248
9.934	14.036		5.422
9.934	14.036		5.422
9.934	14.036		5.422
10.849	14.202		5.596

Showing 1 to 10 of 324 entries Previous 1 2 3 4 5 ... 33 Next

[Simulate on Imported Data](#) [Download above result](#)

- “Download Above Results” saved the outcome of import data simulation

## 4- Optimisation

The optimisation page can be used to derive values for model predictors that are predicted based on a specified target variable.

Model Introduction   Model & Data Import   Visualization   Simulation   Optimisation

### Process optimiser (Non Linear Optimisation)

Select the Target Variable

Mean\_Seal\_Strength(monoPP\_Haiti)

- The optimisation page can be used to derive the values of the model predictors that are predicted based on a specified Target variable.
- The solution can be further constrained by minimizing or maximizing an objective function.
- Objective function is defined as a linear combination of model predictors.
- Select minimization or maximization as per need by clicking on the checkbox.
- Select the desired inequality from "less than or equal to", "equal to" and "greater than or equal to".
- Input the desired value of the Target variable.

- The red box shows the selection of target variable (The equation that the user wants to optimise for)

### Non-Linear Optimisation

All the equations are non-linear in nature

Objective Type

☒ Minimization   ☐ Maximization

Select the inequality type

less than or equal to

Enter the Target variable value

10

### Objective Function Table

- Enter the allowed range for each model predictor by editing the 'Lower Bounds' and 'Upper Bounds' columns in the below table.
- The objective function is defined as a linear combination of the predictors whose coefficients are given in the 'obj coeff' column.
- The values in this column are defaulted to one and they can be edited as per the requirements.
- Press the 'Run optimiser' button to generate the optimal solution.

Show 10 entries   Search:

	Predictors_[Expected lower bound, Expected upper bound]	obj_coeff	Lower Bounds(editable)	Upper Bounds(editable)
1	Sealing_Pressure_[30,110]	1	30	110
2	Sealing_Time_[200,700]	1	200	700
3	Sealing_Temperature_[100,240]	1	100	240
4	Layer_Thickness_[15,100]	1	15	100

Run Optimiser   Reset to defaults

- This solution can be constrained by minimizing and maximizing an objective function.
- The objective function is the product of weights of the corresponding predictors with their values
- Select minimization or maximization as per need by clicking on the checkbox in the red box.

- Select the desired inequality from “less than or equal to”, “equal to” and “greater than or equal to
- The first column shows the predictors along with their expected lower and upper bounds which are given in the brackets
- Obj\_coeff column is set to a default at 1 and is used for assigning weights to each predictor
- Change the lower and upper bounds of the predictor variable
- Once the changes are made click on “Run Optimiser”

### Results

- The Target variable value associated with the predictor values, is shown in this table

Show  entries Search:

Target variable	Value
Mean_Seal_Strength(monoPP_Haiti)	8.215

Showing 1 to 1 of 1 entries Previous 1 Next

### Predictors

- The "Predictors" table show the optimised value taken by each predictor to obtain the optimised Target variable value.

Show  entries Search:

Predictors	Value
Sealing_Pressure_[30,110]	30
Sealing_Time_[200,700]	200
Sealing_Temperature_[100,240]	100
Layer_Thickness_[15,100]	15

Showing 1 to 4 of 4 entries Previous 1 Next

### Objective Function Value

The objective function value resulting from the optimisation is : 52195

[Download above result](#)

- The results table shows the Predicted Value of the response variable
- The predictors table show the value taken by each predictor to obtain the Predicted Response variable value
- Download above results saves the results generated from non-linear optimisation

## Global Download

### Global Download


Download all the results that have been generated throughout the app

[Proceed to download all Results](#)

## Global Download

Download all the results that have been generated throughout the app

Proceed to download all Results

 Download above result

- Press on proceed to download all Results
- The “Download above Results.” Will appear, click on that
- Global download allows the user to download all the results that is manual entry simulation, import data simulation and the results of optimization.
- Please note that only results that are generated will be downloaded.