ArcelorMittal

ONTOTRANS

OntoTrans user case: Optimal process parameters for achieving target mechanical properties for a Section Mill

OVERVIEW

Innovations in the steel industry are essential for energy efficient, lightweight and sustainable products, while meeting the demanding requirements on mechanical properties.

The challenge is to master the relationship between process parameters and properties of hot-rolled H-beams at a Section Mill. Currently, process and properties are managed via testing procedures, which use up significant time and resources, and generating large sets of data.

The ultimate objective is to achieve the ability to determine the process parameters for a given set of required mechanical properties of a target future product.

This is implemented and demonstrated as part of the H2020 OntoTrans projected via an ontology based Open Translation Environment (OTE).
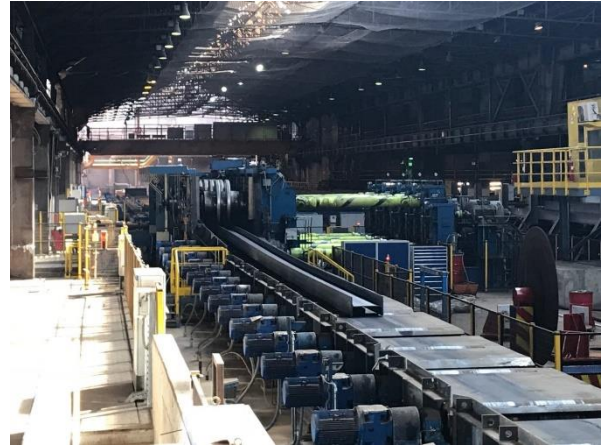

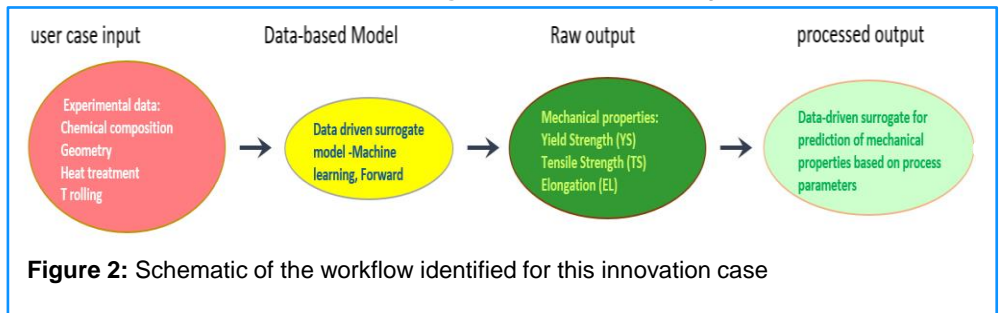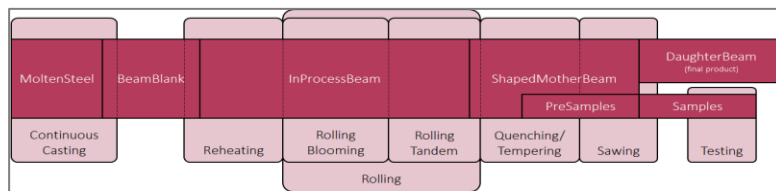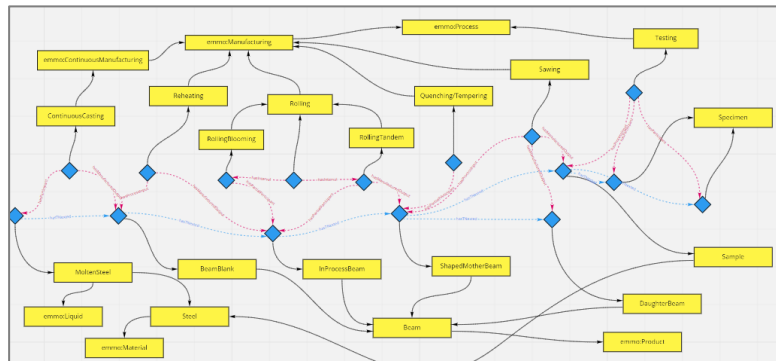**Figure 1:** An H-beam being rolled at a section mill

Figure 2: Schematic of the workflow identified for this innovation case

CONSISTENT KNOWLEDGE REPRESENTATION

- Identify and define all the steps in the section mill steel beam manufacturing process.


- Build an ontology of the underlying manufacturing processes.

- Use MoDS Agent via the OTE to solve the objective demonstrated in figure 2. This will require the use and application of data-driven models, multi-objective optimisation and multi-criteria decision-making (next page).

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THE SOLUTION

- MoDS Agent to build data-driven surrogate models to describe the relationship between inputs and outputs.
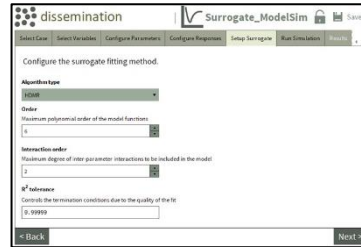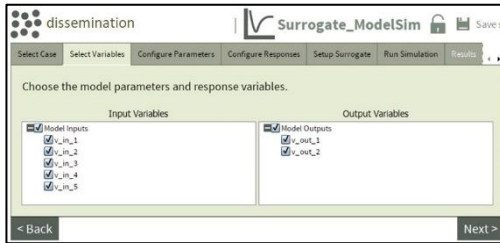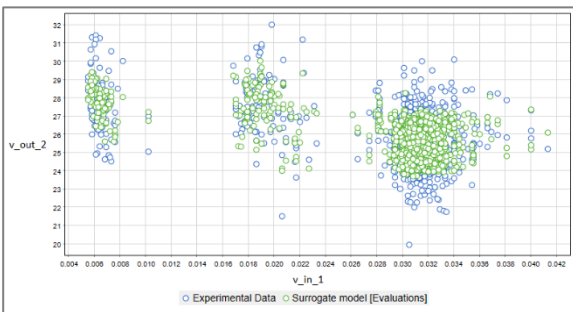

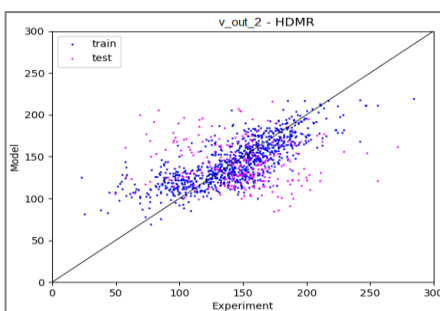- Perform multi-objective optimisation (MOO) over the surrogate models to identify the Pareto points.
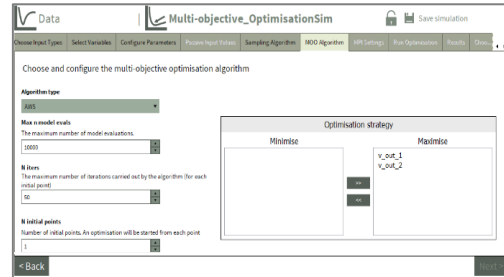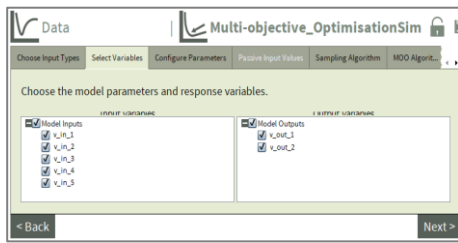
- Perform multi-criteria decision-making (MCDM) on the Pareto points to allow the user to chose the best point based on the mechanical properties requirements for the beam.

THE RESULTS

- Create a surrogate model and use multiple ways to validate the accuracy of the results. Here, a section of the surrogate model showing an example of the relationship between an input variable and an output variable is shown (top plot). In addition, the accuracy of the surrogate model is demonstrated using the 'model-vs-experiment' plot for each output variable (bottom plot).

- Perform multi-objective optimisation (MOO) on the surrogate model to identify the Pareto optima cases. In the example demonstrated in the plot below, the goal is to maximise the two output variables (mechanical properties, i.e. tensile strength and toughness). The red points, known as the Pareto front indicate the best points (best manufacturing condition) to achieve the maximisation.
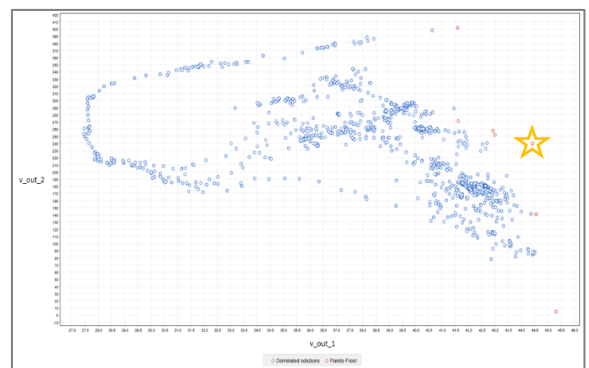
- Further, multi-criteria decision-making (MCDM) is applied to identify the most appropriate of all the optima cases based on the beam's mechanical properties requirements. For example, in the case below, if the first variable needs to be in the range of 44-45 and the second variable in the range of 230-250, the user needs to set the manufacturing conditions corresponding to the star-point.

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