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Estimation of Rolling Process Variation by Usage of a Monte Carlo Method

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Background. Rolling simulation, especially for groove rolling, is heavily dominated by use of finite element methods, but simulating a full pass sequence often takes several hours. Simpler models offer high-speed simulation within seconds at the expense of resolution and accuracy. In mechanical engineering, Monte-Carlo approaches are well known for analysis of fabrication tolerances in component assembly [1;2]. By usage of fast simulation cores, this technique becomes available for analysis of process variations in groove rolling, since computational costs are crucial due to the need of hundreds or thousands of simulation runs.

Procedure

Rolling process variations can be classified in two groups: first, variations of the input material, such as actual dimensions, temperature and microstructure state; second variations occurring during processing, such as transport times, environment temperature and tool wear.

The regarded process was the operation of the experimental semi-continuous rolling plant at the Institute of Metal Forming (IMF). Simulations were carried out by use of the open source rolling framework PyRolL [3], developed at IMF. The main part of process parameters was considered as constant, but some were described as a statistical distribution. For each simulation run a set of actual sample values of the distributed parameters was drawn using a random number generator. Selected result values were described by use of statistical methods to analyze the variational behavior of the process in behalf of the two variation classes.

Key findings

- Variations in input material and in processing steps are highly different in their effect on the product; the latter are more crucial
- Variations in input material tend to vanish with increasing number of processing steps
- Variations in processing steps accumulate and lead to high variation of product properties

References

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