Chair of Metal Forming and Casting
TUM School of Engineering and Design
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Data-driven modelling for process-oriented topology optimisation

Motivation

In recent years, the use of load-oriented optimization (topology optimization) has become common in the design of cast components. Topology-optimized components offer the advantage of reducing component weight while maintaining high stiffness and component strength. Common optimization software currently considers the casting process only by simple manufacturing constraints, such as minimum wall thickness, avoidance of undercuts or draft angles. By now An integration of extended knowledge of the casting process is insufficiently represented. As a result, the current state of the art requires alternating topology optimization and casting simulation. This iterative procedure is associated with high personnel and time expenditure. The work of this project is the development of data-driven models to allow an evaluation of the casting process for arbitrary geometries without time-consuming simulation and can thus be integrated in the topology optimization.

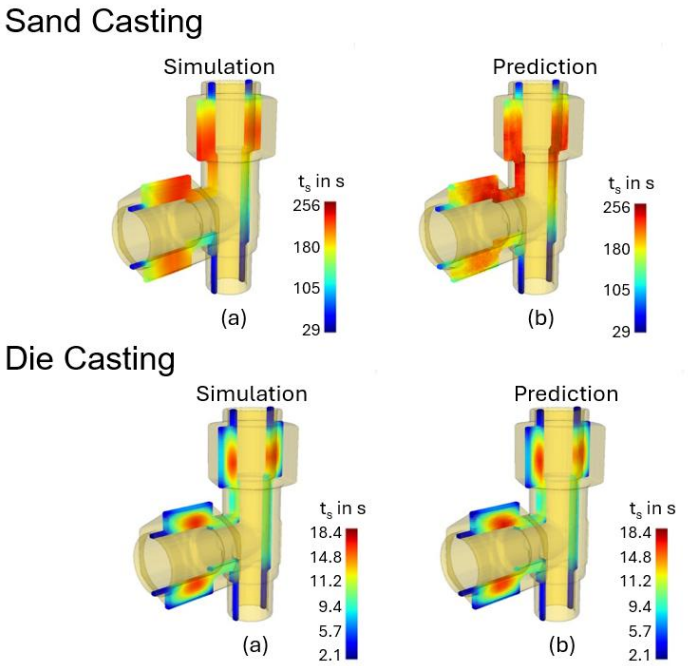

Figure 1: Estimating the local solidification time of a simple geometry using the data-driven approach.

Approach

Good foundry experts often identify problematic and defect-prone component regions even before the actual casting process. This fact, as well as existing geometric evaluation methods such as modulus calculation, indicate that a large part of the castability can already be assessed based on the component geometry. Therefore, in this project a data-driven model is developed, which allows a local assessment of castability based on the component geometry.

For this purpose, different architectures of neuronal networks are investigated as possible models, and a methodology is developed how arbitrary geometries can be considered in those models. Subsequently, a procedure will be developed which, based on these results, allows an automated adaptation of the geometry in order to integrate it into the structural optimization.

Outlook

As part of the project, a model has already been developed for predicting the local solidification time in the sand casting process on the basis of arbitrary component geometries. The results were validated by means of experimental investigations. As a further goal, the model should now be further developed to take into account more possibilities, such as the use of chills, in the casting process.

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