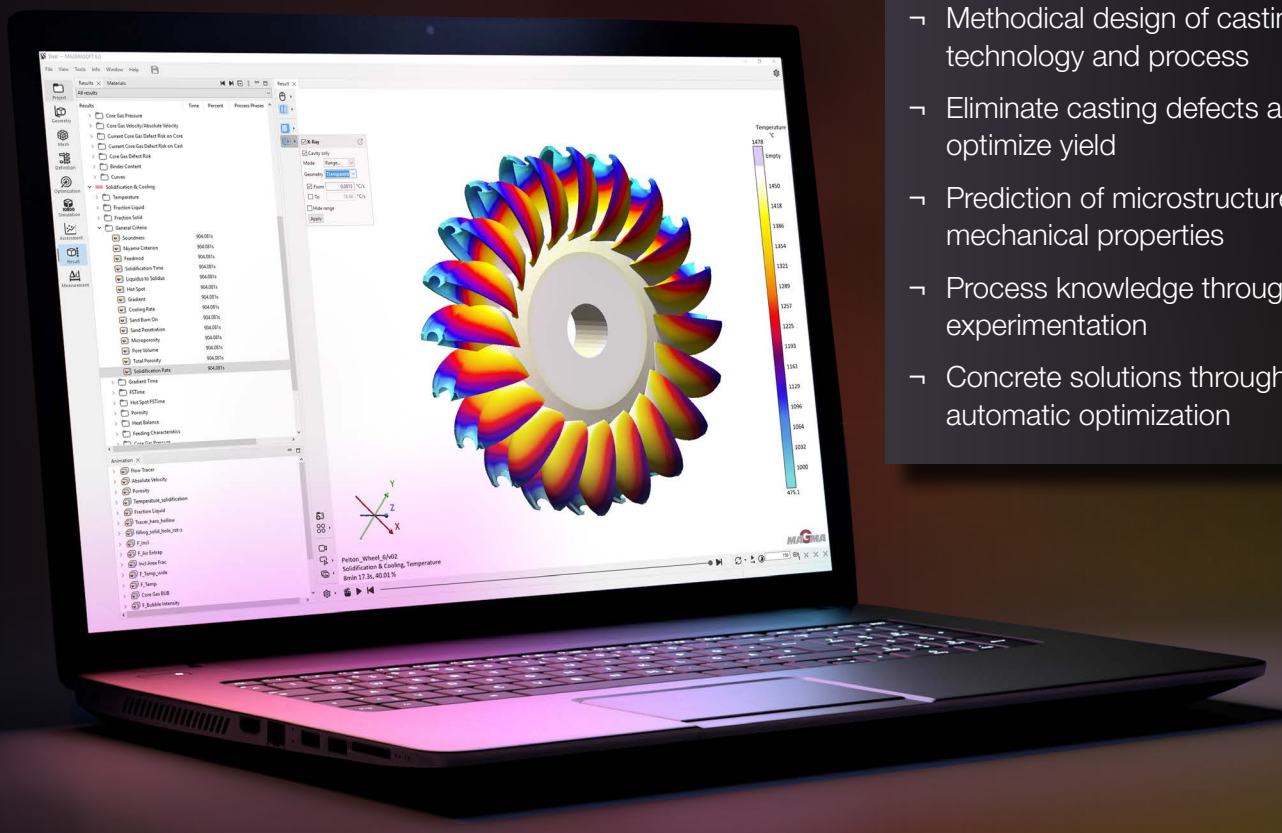
MAGMA Steel 6.0

Autonomous Engineering

Steel Casting

- Robust solutions for steel casting
- Methodical design of casting technology and process
- Eliminate casting defects and optimize yield
- Prediction of microstructure and mechanical properties
- Process knowledge through virtual experimentation
- Concrete solutions through automatic optimization



Robust, Economical, Fast, **Optimized**

Optimize all aspects of steel casting production and find the best solution for your requirements — with MAGMASOFT® autonomous engineering.

MAGMASOFT® is the comprehensive and powerful simulation software for all aspects around designing and improving steel casting quality, mold design and process robustness while ensuring optimal profitability. The focus is on your resources, time and costs.

With MAGMASOFT®, you use simulations in an automated virtual design of experiments or genetic optimization. The result is Autonomous Engineering – systematic and fully automated decision-making for your production conditions.

With Autonomous Engineering, you can simultaneously pursue different quality and cost objectives. From securing product quality for new alloys, to the final design of gating and risering and the mold, and the continuous improvement of profitability in your production.

MAGMASOFT® autonomous engineering and MAGMA Steel:

- Support you in the comprehensive prediction of product quality and a robust process layout for steel casting.
- Offer you a virtual test environment for the optimization of your productivity.
- Enable you to make quick decisions and save time for all parties involved.
- Allow proactive quality management by understanding process fluctuations.
- Improve communication and cooperation within your organization and with customers.

Targeted and Systematic Success

The MAGMA APPROACH, which is fully integrated in MAGMASOFT® and MAGMA Steel, is a systematic methodology for achieving your objectives using virtual experiments. In combination with MAGMASOFT® autonomous engineering, secured actions can be identified and implemented to achieve continuous improvements, without economic risks.

The MAGMA APPROACH supports you at every stage of the product development or improvement process, through a systematic methodology. The result is a robust casting process that is optimally designed for the desired objectives and enables stable production conditions taking into account alloy chemistry, melting practice and metallurgy.

Set Your **Objectives**, Define Your **Variables**, Specify Your **Criteria**

Efficiency and highest quality in steel casting today demands maximum robustness and optimum process design. Develop innovative steel castings holistically with MAGMASOFT® autonomous engineering and find the optimum solution for your requirements.

The realistic modeling of the entire process allows the assessment of the flow conditions during casting, solidification in the mold, subsequent unpacking of the part and subsequent heat treatment to adjust mechanical properties.

Mold Filling

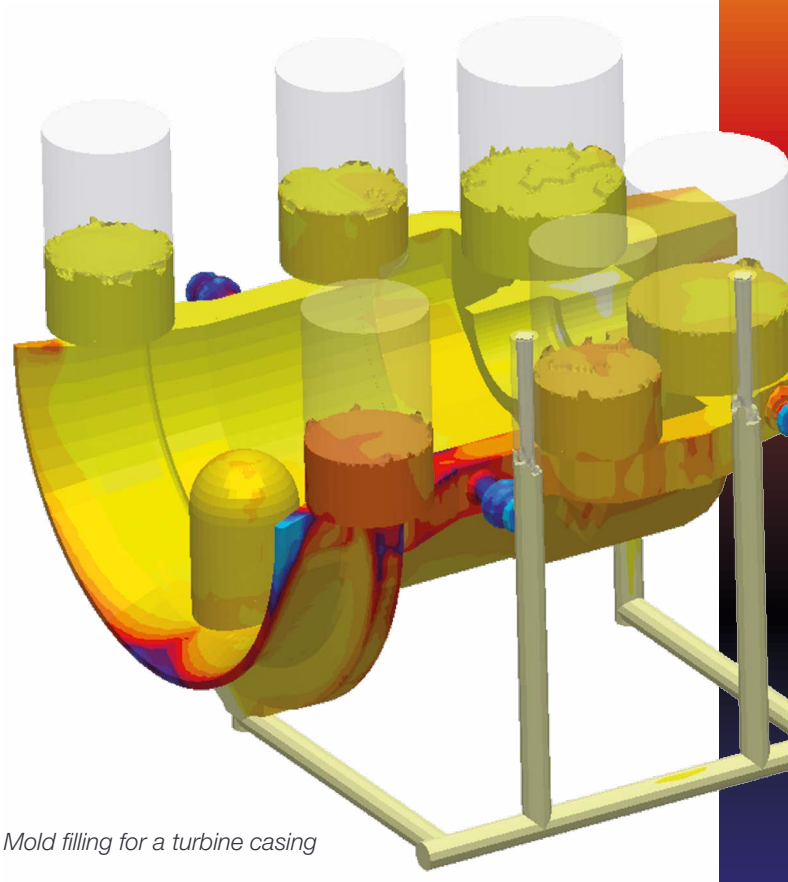
A robust and reproducible mold filling is an important prerequisite for avoiding defects. The layout of a gating system with MAGMASOFT® allows you to identify the root causes of possible defects, to understand them, and to eliminate them by systematically investigating the relevant process variables.

The systematic evaluation of the mold filling helps you to avoid flow-related defects such as

- Slag, sand and reoxidation inclusions
- Entrapped air and gas bubbles
- Cold shuts and misruns
- Mold erosion

Investigate impacts on the quality of mold filling through the systematic variation of

- Pattern plate layout
- Runner and gate dimensions
- Pouring rates and filling times



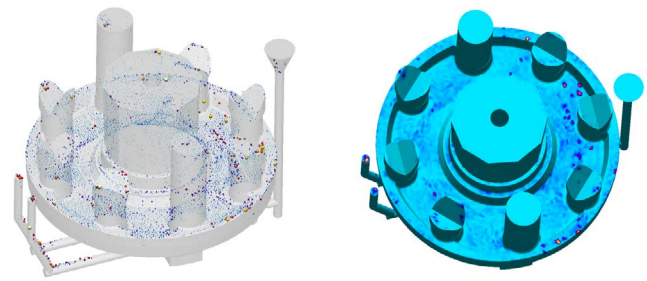
Mold filling for a turbine casing

Convection and Segregation

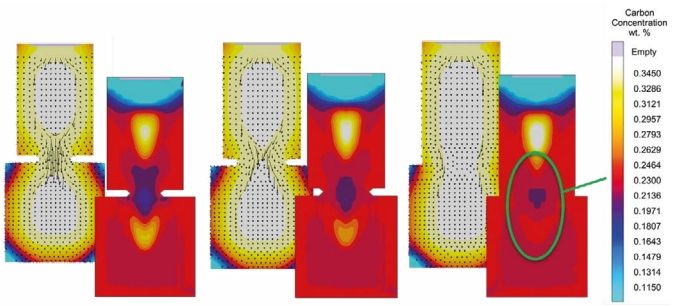
MAGMASOFT® considers the flow behavior and the temperature distribution in the solidifying casting due to thermal and solutal convection.

Through coupling with a segregation model, the redistribution of alloying elements and macrosegregation can be predicted.

Local alloy concentrations can thus be determined quantitatively for different elements.



Prediction and evaluation of reoxidation inclusions

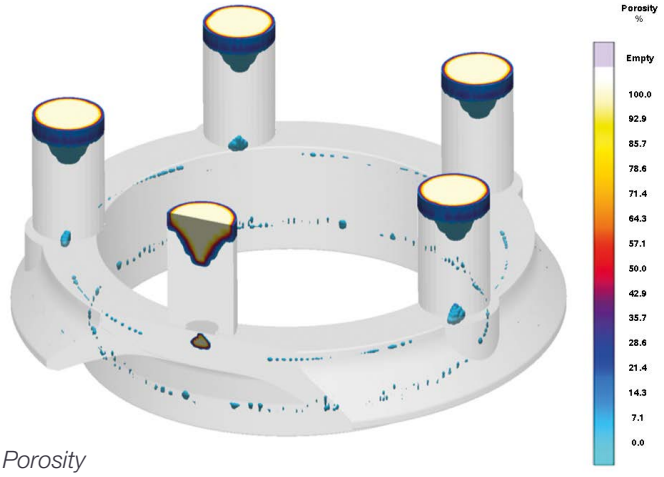


Predicting under-riser segregation

Solidification

During the solidification of steel castings, various process variables influence the quality of the casting, such as the composition of the material, feeder, chills, isolating materials and contact sand or cores. MAGMASOFT® takes these process variables into account when predicting casting defects such as

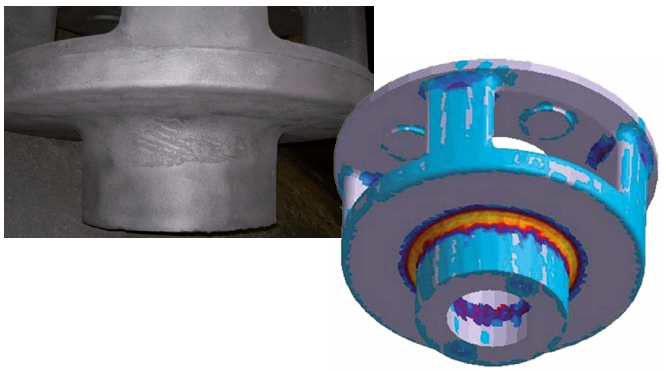
- Shrinkage pipe and porosity
- Core gas defects
- Surface quality



Porosity

Residual Stresses and Distortion

The casting shrinks during cooling. Depending on the component geometry and the mold stiffness, residual stresses build up in the casting. The detailed prediction of casting residual stresses and component distortion is seamlessly integrated into the virtual process chain. Examine important variables such as the shakeout time, the removal of the gating and feeders or machining on possible cracks and the dimensional accuracy of the casting.



Burn-on: real casting and prediction

Design of Gating and Risering

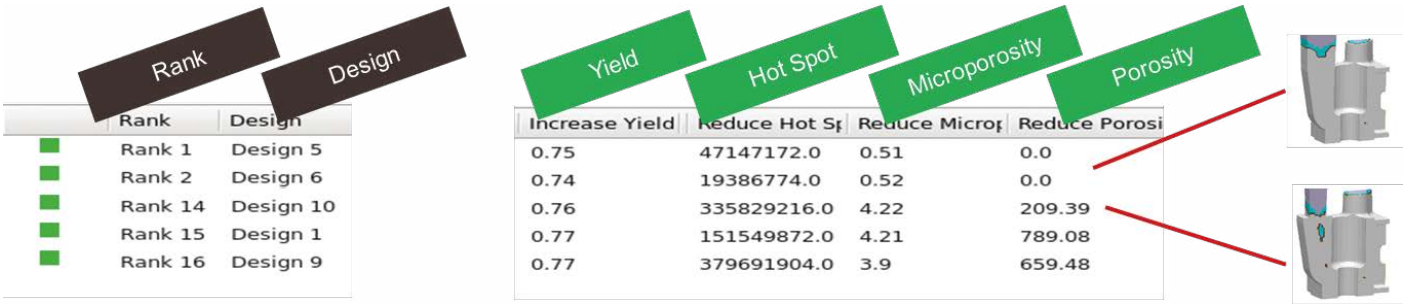
MAGMASOFT® supports you in the design, evaluation and efficient design of your casting processes with integrated possibilities to statistically evaluate the virtual experiments. This allows you to identify robust process windows and find optimal operating points autonomously. The requirement for high product quality at the lowest possible cost is thus reliably guaranteed for the steel casting process.

Use different capabilities for automatic variation of geometries to

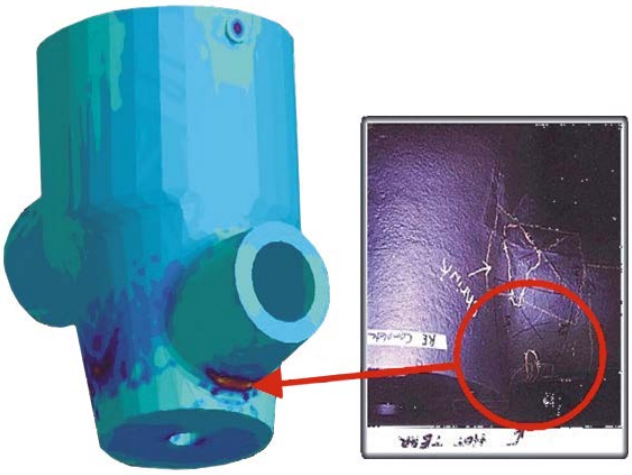
- Exchange imported CAD geometries
- Use parametric geometries from the MAGMASOFT® database
- Move geometries on surfaces or along trajectories

Optimize:

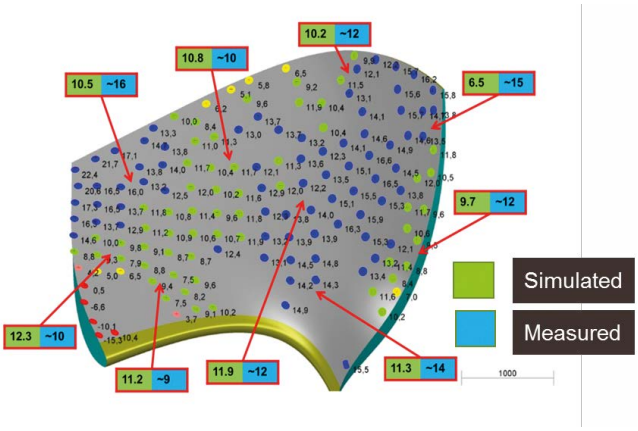
- Local thermal modulus
- Solidification path and hot spots
- Feeding patterns
- Macro- and microporosity



Interactively evaluate virtual DoEs



Hot tear: prediction and real defects

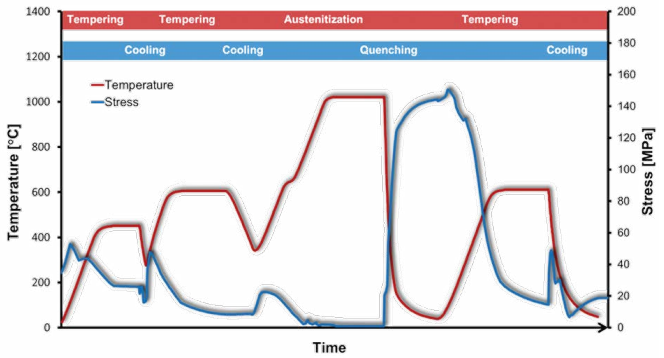


Comparison of measured and calculated distortions

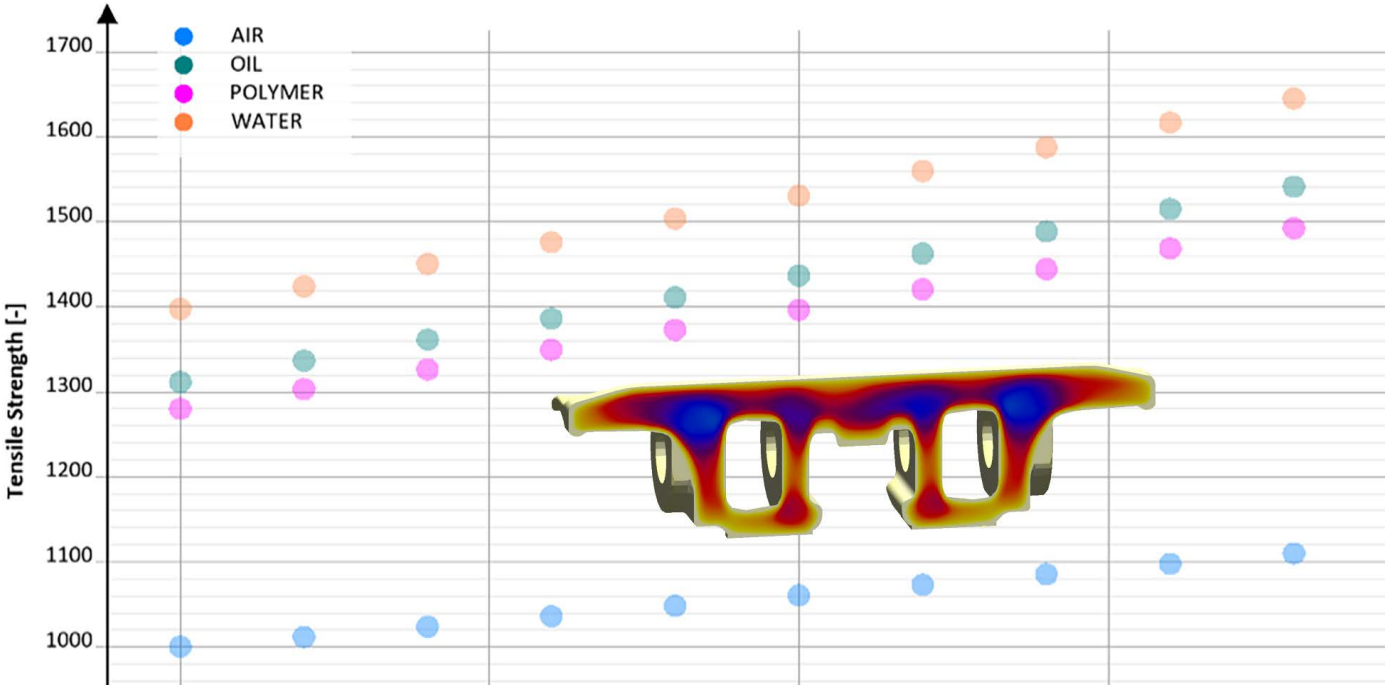
Heat Treatment

Heat treatment is typically a requirement for all steel grades. MAGMASOFT® takes into account all the process steps in heat treatment, from heating and austenitization to quenching, tempering and further cooling to room temperature. Optimize your heat treatment by optimizing

- Austenitization times and temperatures
- Conditions for quenching and tempering
- Microstructure after heat treatment



Comprehensive consideration of heat balance and stress sequence during heat treatment



Virtual experiments: calculated tensile strength as a function of %C for different quenching media

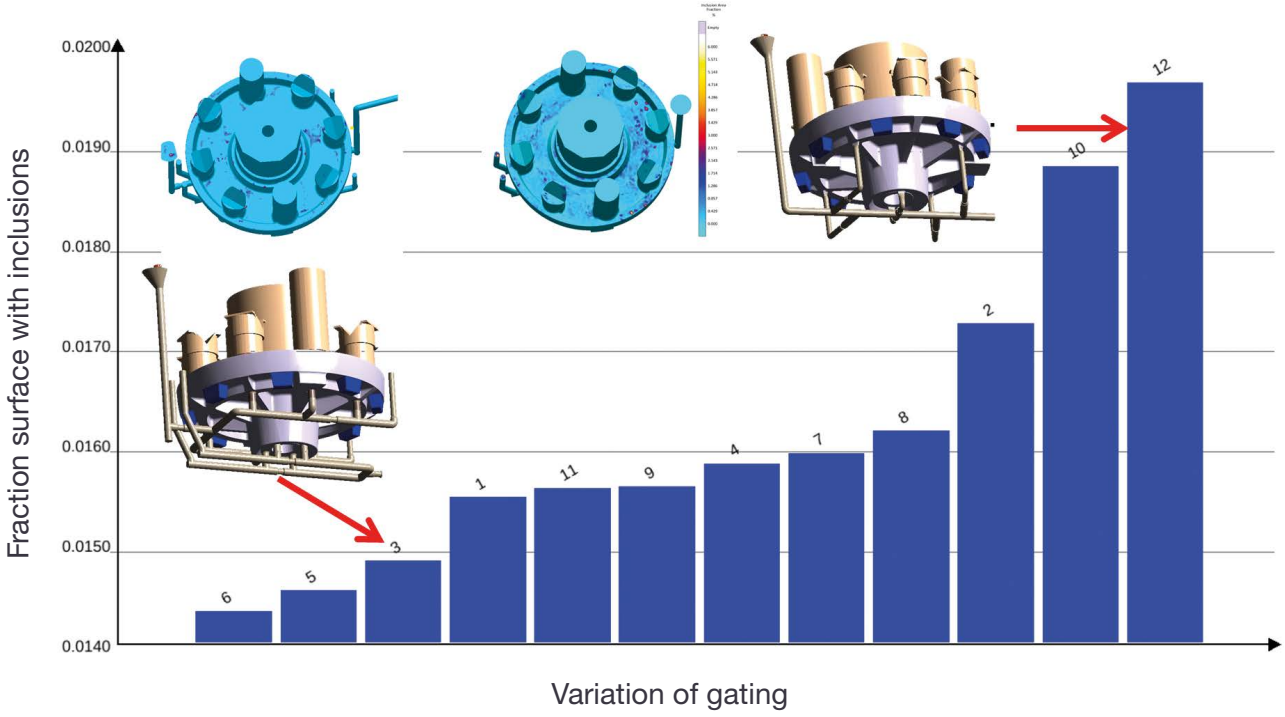
Optimization and Robust Processes

MAGMASOFT® offers extensive capabilities for virtual designs of experiments and optimization. This enables the analysis of process windows without economical or production risks. In addition to optimizing the casting layout, numerous process variables can be analyzed for setting robust manufacturing conditions.

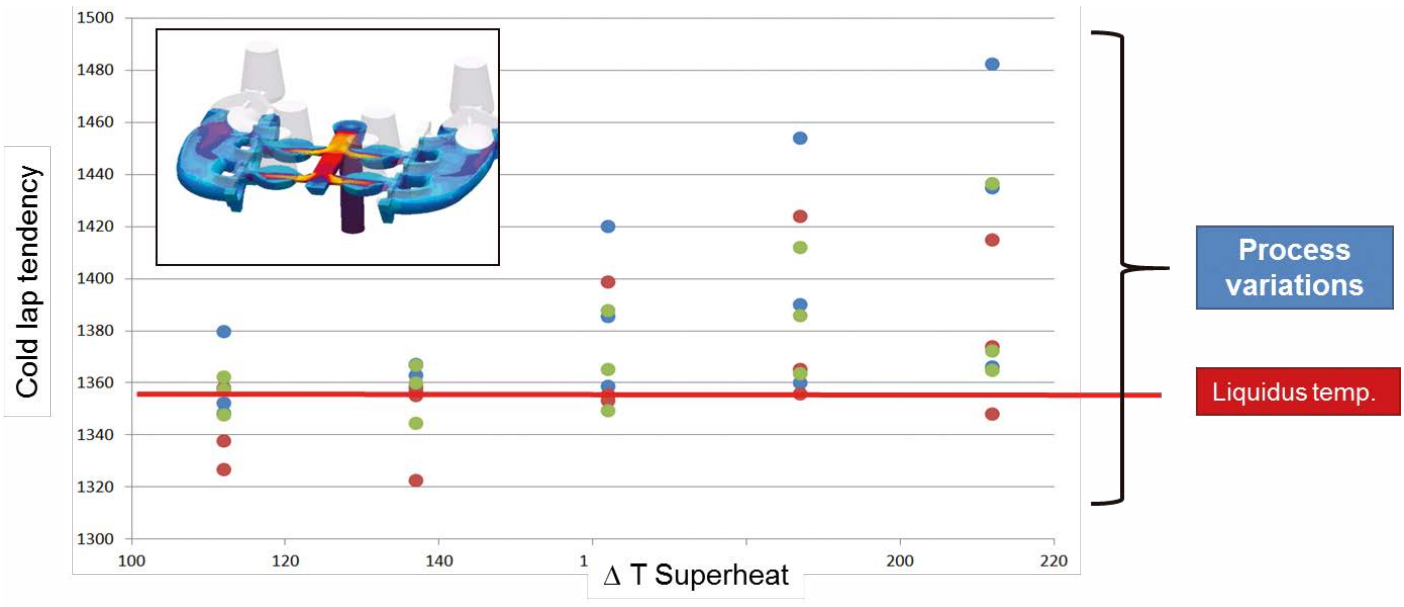
Determine the influence of process fluctuations on the solidification behavior of your castings through systematic designs of experiments. With MAGMASOFT® autonomous engineering, you can quantitatively evaluate main effects and correlations, and determine concrete actions for your production even before the first casting has been made.

Comprehensive statistical evaluation methods support you in determining optimal conditions for

- Casting optimization with regard to surface quality and segregation
- Avoidance of critical phases during the cooling process
- Heat treatment that conserves resources and is tailored to the desired microstructure distribution and required mechanical properties



Statistical evaluation of inclusions for different gating designs



Determination of robust process conditions, here: cold run tendency for different casting temperatures and typical process fluctuations

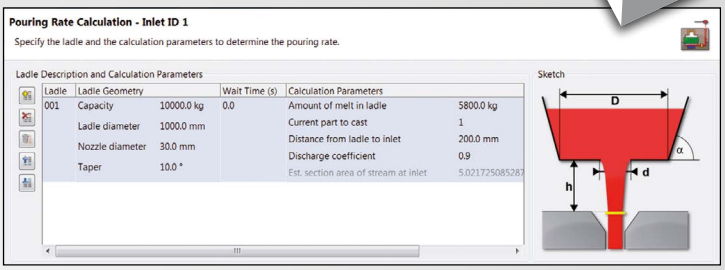
Work **Efficiently** and **Systematically**

Your time is limited! To achieve your goals, it is crucial to systematically and efficiently utilize all the available possibilities in MAGMASOFT®'s comprehensive toolbox.

Assisted Modeling

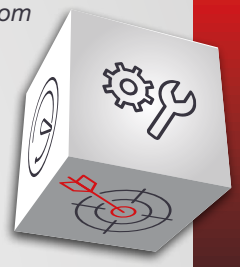
Use the practice-oriented visualization of all relevant process steps for optimization of the entire process.

Versatile wizards and convenient CAD functions support you in targeted and effective model preparation and enable a short time to answer with minimum effort.



Outflow from the bottom pour ladle – calculated from ladle geometry and current melt quantity

- Calculation of the flow from the plug ladle and the ladle discharge characteristic
- Determination of the local thermal modulus for the feeder dimensioning



- Determination of volume and weight of the casting, machining allowances, gating and risering systems, mold, cores and chills
- Key figures for the sand/metal ratio, yield and fettling demands

Act & Check Your **Improvements**

Success is more than software and hardware. MAGMA's professional team is ready to comprehensively support you in realizing your goals. You can take advantage of the services of our MAGMAacademy, engineering and support teams when and how it suits you, and all from a single source.

Implementation

All MAGMASOFT® programs are more than just software. They offer a methodology for optimizing engineering, communication and profitability in your organization.

Even before starting with our software, we will take the time to discuss with you the most important factors to ensure an effective and secured use of our tools based on your situation: from the required computer hardware through the qualification and training of users, to jointly defining objectives regarding where you want to be in the next year.

Whether you are a new customer or a long-time user of our software: We have plans with you!

MAGMAsupport

MAGMAsupport stands for the competent, methodical and fast support of our customers worldwide regarding all questions in the application of and problem-solving with our products. With the MAGMA APPROACH, our qualified support staff will help you to make better use of our software every day.

MAGMAacademy

The MAGMAacademy systematically supports you in the implementation of both casting process and virtual optimization, from the initial rollout to the comprehensive application of Autonomous Engineering throughout the entire organization.

In our training courses, workshops and seminars, we convey interdisciplinary understanding across all processes and departments for the best possible use of MAGMASOFT® – conducted at our offices or through a customized solution on-site.

MAGMAengineering

As an independent and competent partner, MAGMAengineering supports a successful virtual product development, tooling design and optimization of your robust foundry processes within the framework of engineering projects.

An interdisciplinary and international team of experts, with numerous years of casting expertise, is available to work with you using MAGMASOFT® autonomous engineering to address your challenges.

Casting Knowledge.
In a Software.

MAGMASOFT® 6.0

MAGMASOFT®
autonomous engineering

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