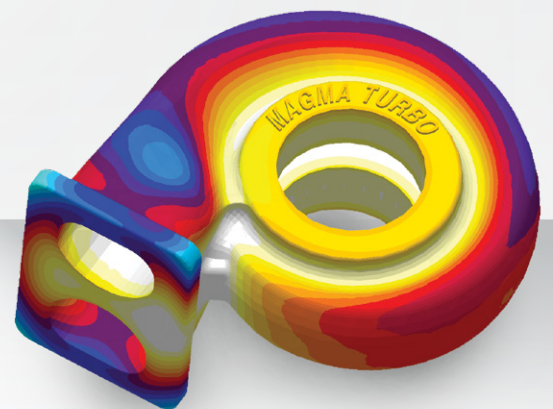


AUTONOMOUS **ENGINEERING**[™]

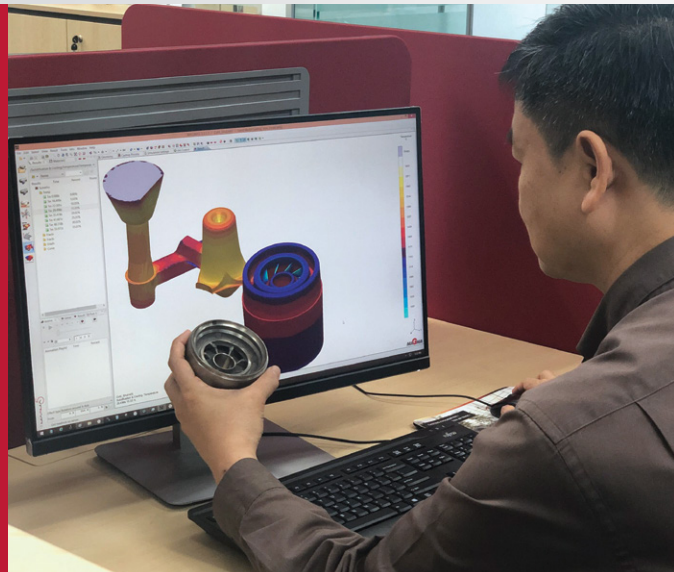
CAST IRON

- Eliminate defects before they become a reality
- Identify significant process and design variables
- Consider process variability
- Balance production costs with quality
- Predict microstructure and mechanical properties
- Consider iron quality, chemistry and mold strength





THE MAGMA APPROACH



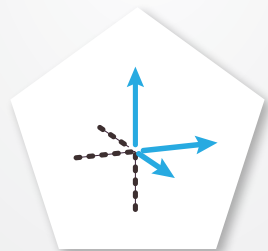
Targeted, Systematic Path to Success

Successfully navigating the highly complex iron casting process doesn't just happen by chance... it requires a game plan that will get you to your final goals.

The MAGMA APPROACH is that game plan. Simply put, this systematic problem solving method is not only integrated into MAGMASOFT® autonomous engineering, it is the foundation of everything we do as an organization.



SET UP YOUR
OBJECTIVES



DEFINE YOUR
VARIABLES



SPECIFY YOUR
CRITERIA



KEEP THE TASK
EFFICIENT



CHOOSE YOUR
METHOD



ACT & CHECK YOUR
IMPROVEMENTS

SET UP YOUR

objectives

We know that foundry engineers work hard to produce quality castings, meet deadlines and reduce costs. Your job is complex and keeping all of the moving pieces together can be a challenge. We understand this and so does our software.

IMPROVED QUALITY

Every time a mold is poured the potential to create casting defects exists. With every casting defect comes the threat of increased scrap rates, lower production rates, increased costs, increased lead times and unhappy customers.

ON TIME DELIVERY

Your customers are counting on the castings you provide for their finished products. To meet their goals, they need their castings on time. Late castings mean lost business for your customer and your foundry.

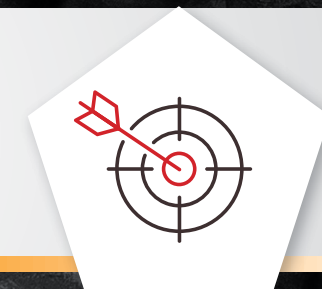
REDUCED COSTS

Your foundry is one of many in a global industry where your customers are seeking to lower their costs and maximize their profits. To be competitive your foundry must consider the impact that material costs, labor, production and defects have on your bottom line.

“At PAPFMY, MAGMASOFT® is utilized to solve crucial issues in regards to casting quality and enhance overall productivity.

It helps us to have virtual detailed insights already at the very early development stage into filling and solidification of the cast parts while tracking various casting defects. The optimization features expedite the ‘trial and error’ process and hence minimize our development cost tremendously. In terms of productivity, we always focus on developing robust processes by continuous optimization of gating designs. With MAGMASOFT®, we achieved our aim which is to stay cost competitive and energy efficient in the market by producing more castings using lesser raw materials.”

*~ Mr. Muhammad Afandi Darwis,
Manager - Product Engineering
& New Sales Development,
Panasonic Appliances Foundry
Malaysia Sdn Bhd, Malaysia*



DEFINE YOUR

variables

To do your job successfully, you have to understand the effects that many different variables have on the casting process. From tooling and casting design to chemistry and melt treatment, to material properties, mold strength, and machine parameters.

We understand and consider these variables and how they impact your casting quality, production rate and costs.

MAGMASOFT® autonomous engineering can evaluate multiple variables at the same time. These variables can include the variation of any casting or tool dimensions, process parameters or materials. The software can consider all of these variables while working to achieve the objectives you have set.

MATERIAL

- Alloy type and exact alloy chemistry
- Mold and core sand
- Mold stability and mold wall movement
- Riser sleeves
- Filters
- Chills

MOLDING METHOD

- Horizontal
- Vertical

GEOMETRY

- Casting
- Rigging

PROCESS

- Pouring temperature and rate
- Sand conditions
- Inoculation and melt treatment
- Shakeout
- Rigging removal and machining

SPECIFY YOUR

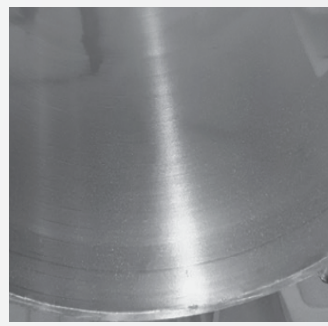
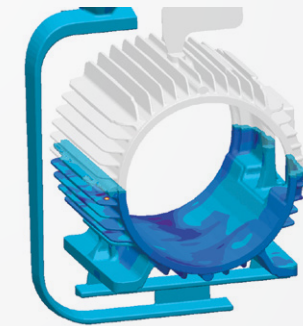
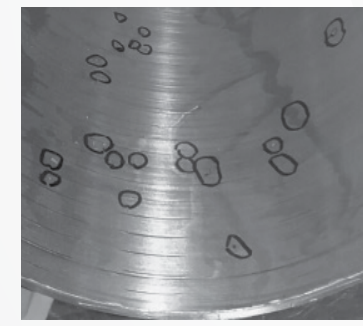
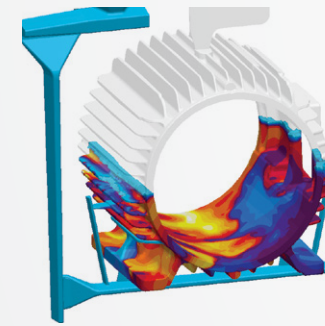
criteria

Before a problem can be solved, it must first be quantified and properly understood. MAGMASOFT® considers your entire process and provides quantitative results that measure progress.

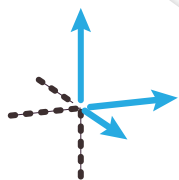
MOLD FILLING

When liquid iron is poured into a mold, there are many opportunities for defects to occur. Analyzing the filling using MAGMASOFT® allows you to avoid defects such as:

- Inclusions
- Entrapped air or core gases
- Misruns
- Cold lap



Air entrapment during filling for baseline gating system (left), reduced air entrapment during filling for optimized gating system (right)



SPECIFY YOUR criteria

SOLIDIFICATION & COOLING

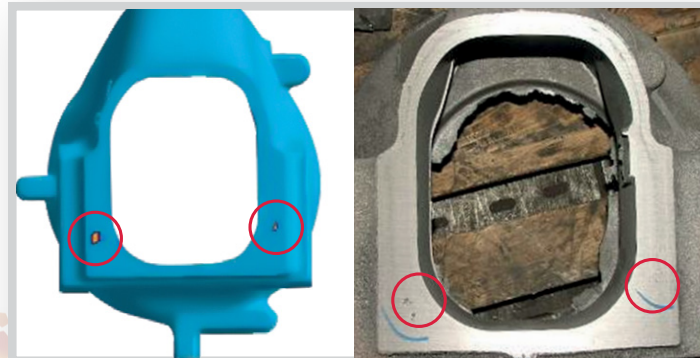
During solidification there are many factors that influence defect formation, such as: the chemistry of the melt, the metal treatment practice used, the mold wall stability and the heat transfer in the casting system and mold.

MAGMASOFT® considers each of these variables when predicting defects that occur during solidification such as:

- Shrinkage porosity
- Binder gas defects
- Burn on sand and penetration



PREDICT

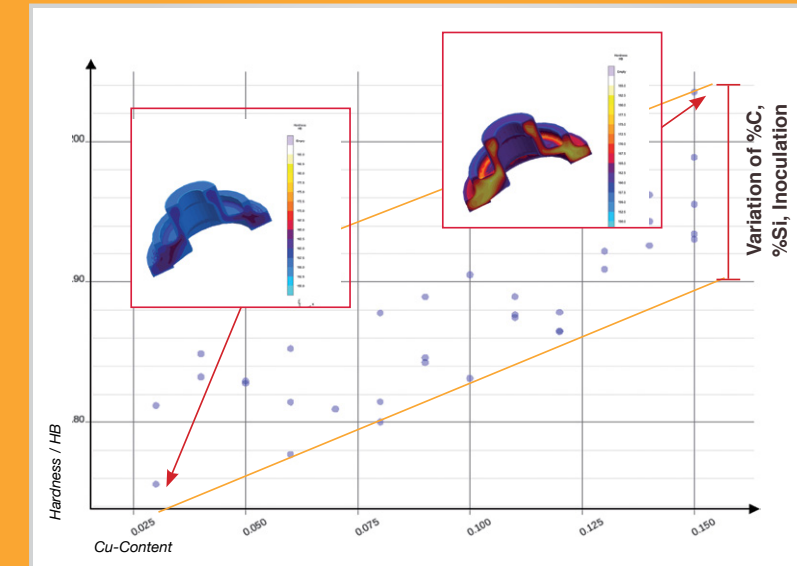


Porosity in a ductile iron casting

MICROSTRUCTURE & MECHANICAL PROPERTIES

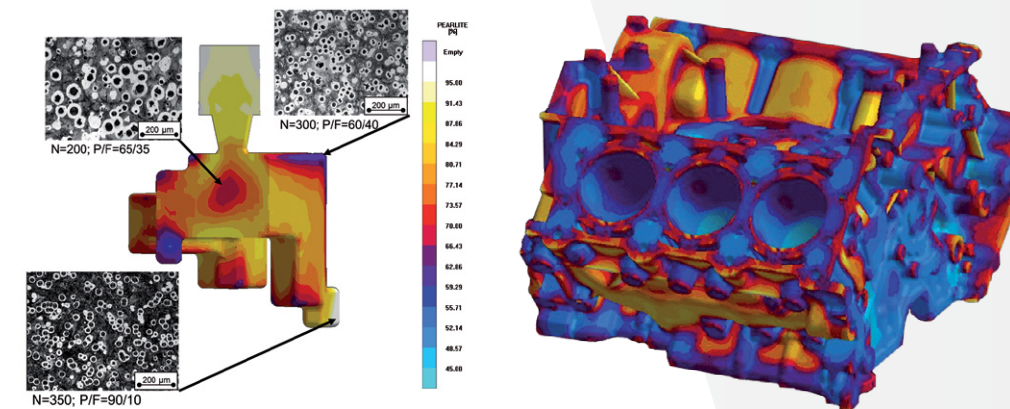
The MAGMASOFT® Iron micromodel helps you avoid:

- Undesirable microstructures
- Out-of-spec mechanical properties
- Poor machinability



Influence of alloy chemistry on mechanical properties

ANALYZE



Local pearlite fractions in a ductile iron casting (left), nodularity distribution in a CGI V6 crankcase (right)



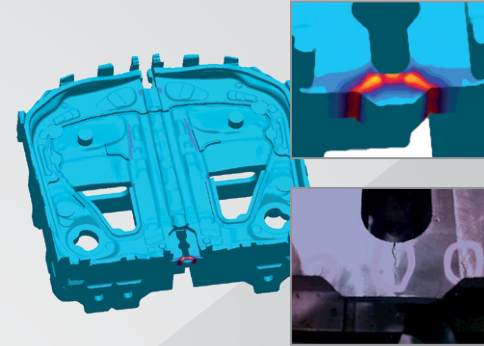
Solidification path for a ductile iron axle housing during cooling

SPECIFY YOUR criteria

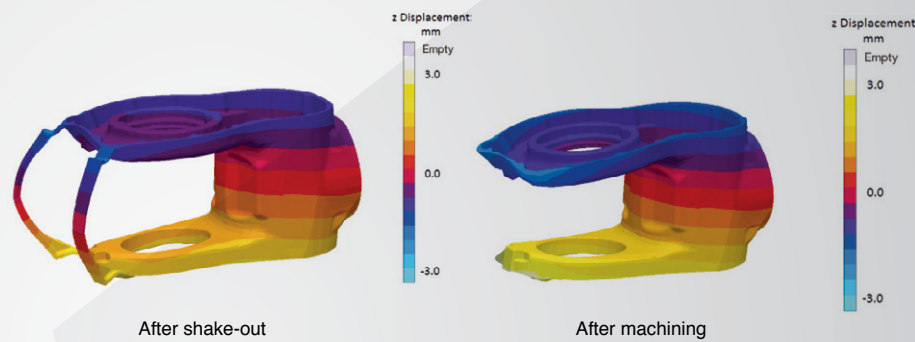
STRESS & DISTORTION

The expansion and contraction of iron castings during the casting and heat treatment process, along with the influence of constraints from the core and mold sections can result in:

- High residual stresses
- Cold cracking
- Excessive distortion



Cold cracking in an iron casting

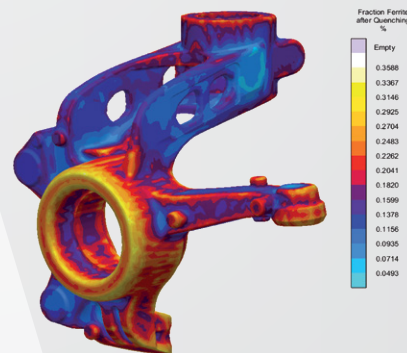


Distortion after shake-out: The two "ears" move towards each other (left);
Distortion after machining: The two "ears" move closer to each other (right)

HEAT TREATMENT

Austempered Ductile Iron (ADI) requires precise process control throughout austenitization, quenching and ausferritization in order to provide the desired microstructure and resulting mechanical properties. MAGMASOFT® accounts for each of these process steps and their specific conditions so that the following can be understood:

- Austenitization time
- Ausferritization time
- Phase distributions



Calculated microstructure distribution in the ausferrite after ADI heat treatment

KEEP THE TASK efficient

Time and engineering resources are at a premium in the iron foundry. You need tools that allow your entire organization to be as productive as possible.

MAGMASOFT® DESIGN TOOLBOX

MAGMASOFT® gives you tools that will save you time and help you to work as efficiently as possible, including:

Tools that save set-up time

- A library of premade and easily editable rigging components, including risers, runners, and sprues
- Quick and easy meshing of any geometry
- Automated geometry changes when testing different design variables

Tools that save calculation time

- A queuing system for prioritizing and scheduling multiple simulations or virtual experiments
- Ability to run multiple designs in parallel to reduce processing time
- Scalable multi-core performance for faster runtimes

Tools that save time analyzing results

- Data analysis tools for quickly identifying significant variables in virtual experiments
- Comparison of results from multiple designs in multiple views simultaneously
- Automated image and movie generation



"Riyue Heavy Industry and its wholly-owned subsidiary Ningbo Rixing Casting produce large and medium-sized cast iron castings for various industries such as railway, wind power & energy equipment, general machine tools and mining machinery. Since its implementation in 2015, MAGMASOFT® has been helping us to overcome various challenges in our production, allowing us to work more efficiently. We trust and appreciate MAGMASOFT® result quality and accuracy, so we have made it an integral part of our process in the development of our new products. We strongly believe that together with MAGMA, our company will rise to higher grounds."

~ Mr. Li Lingyu, Deputy Director of Technology R&D Center, Riyue Heavy Industry Co., Ltd., Ningbo, China

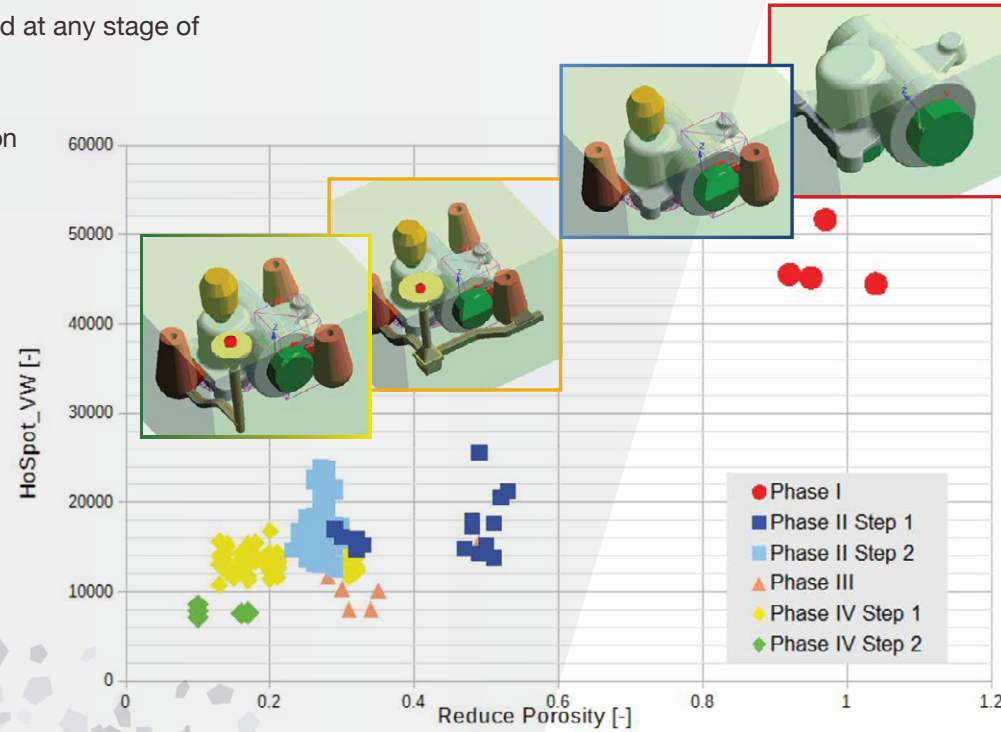
CHOOSE YOUR method

Every project presents unique challenges and requires different strategies to reach your goals. MAGMASOFT® autonomous engineering provides different strategic approaches for each unique project.



CUSTOMIZE YOUR STRATEGY

- Using MAGMASOFT® you can easily define goals using single simulations, design of experiments and optimizations that consider multiple designs at once.
- The influence of many variables can be quickly analyzed when running design of experiments or optimizations.
- Numerical objectives and automated setup help to quickly identify designs that meet competing objectives (i.e. quality and yield).
- Each strategic approach can be used at any stage of product life cycle including:
 - New part development
 - Trouble shooting current production
 - Continuous improvement



Scatter chart illustrating quality improvements during different phases of new tooling development

ACT & CHECK

improvements

Success requires more than just Autonomous Engineering™... it requires a team of professionals to help you reach your goals.

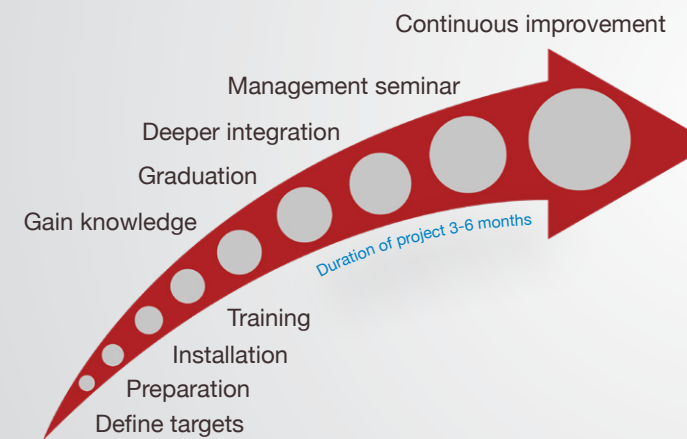
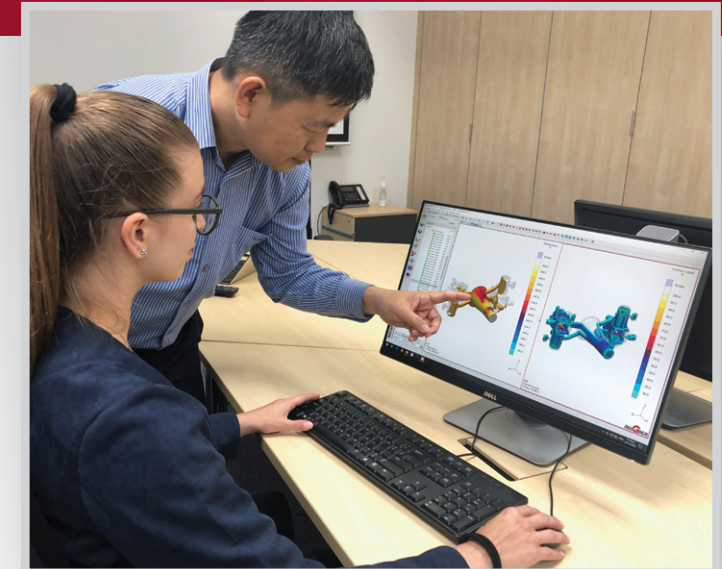
MAGMA provides this team. With our implementation plan, **MAGMASupport**, **MAGMAproject** and the **MAGMAacademy**, we are here to support you every step of the way.

IMPLEMENTATION PLAN

The implementation of MAGMASOFT® autonomous engineering begins with a customized plan that your dedicated Account Manager will review with you on day one.

This plan covers all pertinent information for successfully launching MAGMASOFT® within your organization, including:

- Appropriate software modules
- Hardware requirements and configuration
- Installation & assistance
- Comprehensive training
- Graduation project
- On-site training
- Management seminar



TECHNICAL SUPPORT

Once MAGMASOFT® has been successfully launched at your organization, the implementation plan will transition into an ongoing development plan. Our goal is to establish a long-lasting partnership between MAGMA and your organization.

Our support staff are metal casting experts with a combined industry experience of over 200 years. Our dedicated support engineers will work with you to make sure your organization is consistently meeting its goals, day after day, year after year.



MAGMAacademy

MAGMAacademy is a training and continuing education program at MAGMA. All training and ongoing learning relating to MAGMASOFT®, seminars and workshops are done through MAGMAacademy.



The MAGMAacademy invites non-customers to most of our workshops and seminars, please check out the MAGMAacademy section of our website for more information.



MAGMA interact®

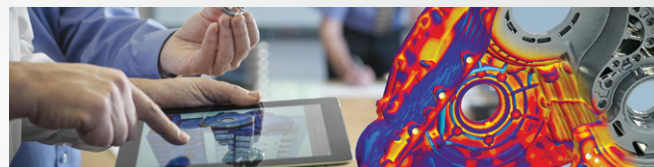


MAGMAinteract® is the 3D-viewer software for visualization of MAGMASOFT® results. It enables the intuitive display of information exported from MAGMASOFT® results within an organization, with suppliers and customers. It also allows quick and easy presentation of information which creates the basis for sound decisions.

Free Download at magmasoft.com.sg/interact

MAGMAproject

Metal Casting Project Engineering Service



MAGMAproject is our engineering service that we provide to everyone who is seeking a comprehensive solution on process optimization using our well proven MAGMA APPROACH methodology together with our experienced foundry engineers, metallurgists and mechanical engineers. We perform several hundred industrial projects yearly around the globe.

Our experts use the full range of the MAGMASOFT® product portfolio to provide solutions. We can help you to:

- Identify the root causes of defects and resolve them
- Improve casting quality
- Increase yield
- Optimize casting parameters
- Reduce production costs
- Get new product knowledge and venture into new markets

We compile and document step-by-step improvements and potential solutions - from a simple solidification simulation to full factorial design of experiments (DoE) or an autonomous optimization of your casting process.

5

MAGMASOFT®
autonomous engineering