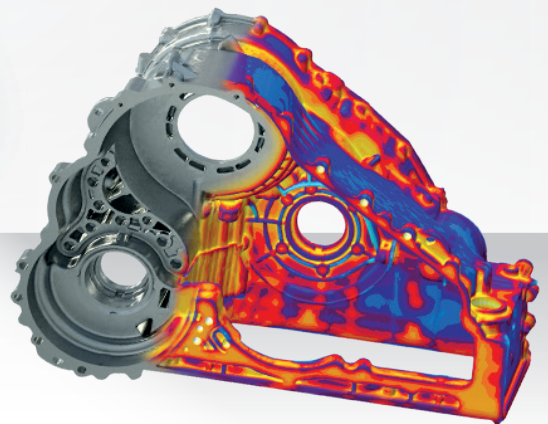# AUTONOMOUS
ENGINEERING™

HIGH PRESSURE
DIE CASTING

¬ Robust cold and hot chamber high pressure die casting

¬ Systematic process and tool design

¬ Process knowledge through virtual experimentation

¬ Practical solutions using autonomous optimization

MAGMA
Committed to Casting Excellence

THE
MAGMA
APPROACH

Targeted, Systematic Path to Success

Successfully navigating the highly complex high pressure die 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 optimization, it is the foundation of everything we do as an organization.

SET UP YOUR OBJECTIVES
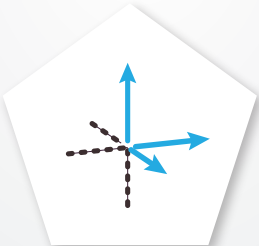
DEFINE YOUR VARIABLES

SPECIFY YOUR CRITERIA

KEEP THE TASK EFFICIENT

CHOOSE YOUR METHOD

ACT & CHECK YOUR IMPROVEMENTS

SET UP YOUR
objectives

We know that die casting 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 part is made 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 die cast facility.

REDUCED COSTS

Your die cast facility 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 facility must consider the impact that material costs, labor, production and defects have on your bottom line.

MAGMASOFT® autonomous engineering is an essential tool for eliminating costly sampling and rework throughout the design and production process. MAGMASOFT® allows effective communication between design and manufacturing teams to ensure immediate success from initial concept casting designs. This directly improves customer satisfaction by reducing production part quality issues and ensuring on-time delivery.

– Clay Rasmussen, Mechanical Engineer, Mercury Marine, Fond du Lac, Wisconsin

**MERCURY** Castings

5

MAGMASOFT®
autonomous engineering

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 process 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 process parameters in addition to casting or tooling design changes. The software can consider all of these variables while working to achieve the objectives you have set.
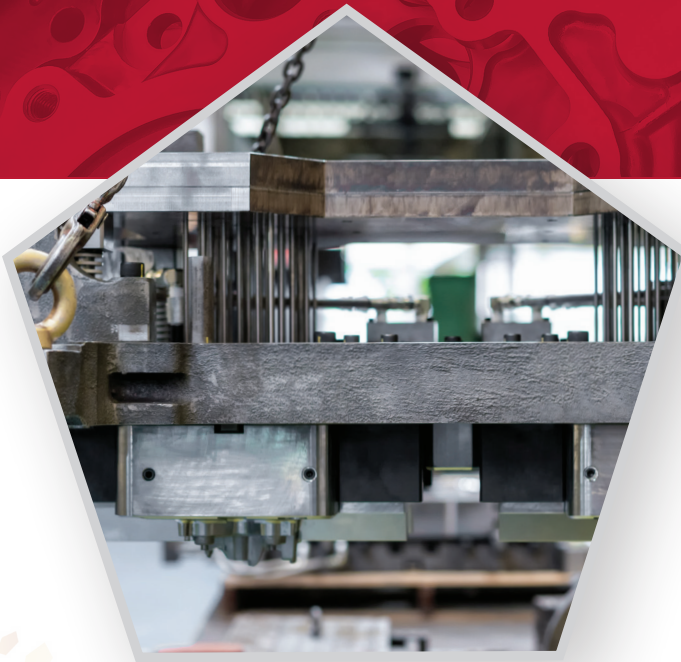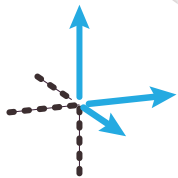
GEOMETRY

- Casting
- Tooling
- Runner and gates
- Vents and overflows
- Cooling lines
- Shot chamber

PROCESS

- Melt temperature and injection rate
- Shot profile and intensification
- Die lubricant application
- Die conditions and thermal balance
- Localized squeezing
- Method of venting
- Degate and trim
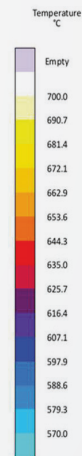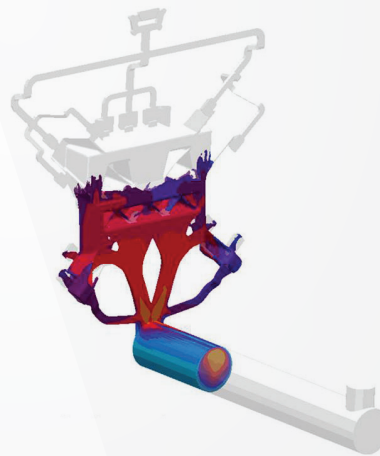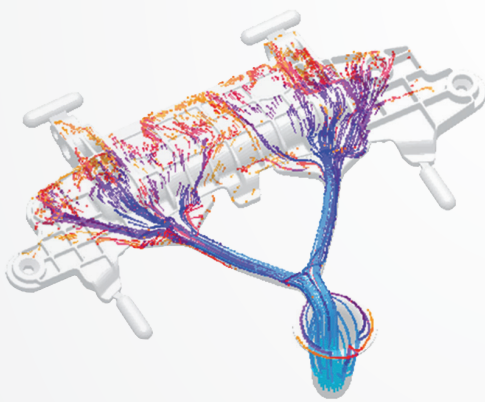- Quenching and heat treatment

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 metal is injected into a die, there are many opportunities for defects to occur. Analyzing the filling using MAGMASOFT® allows you to avoid defects such as:

• Cold flow
• Knit lines
• Blisters
• Entrapped air
• Inclusions

Temperature °C
Empty
700.0
690.7
681.4
672.1
662.9
653.6
644.3
635.0
625.7
616.4
607.1
597.9
588.6
579.3
570.0

Results by considering mold temperature and tracer particles to design robust and profitable gating systems, filling pattern can be analyzed for both hot and cold chamber processes

SPECIFY YOUR
criteria
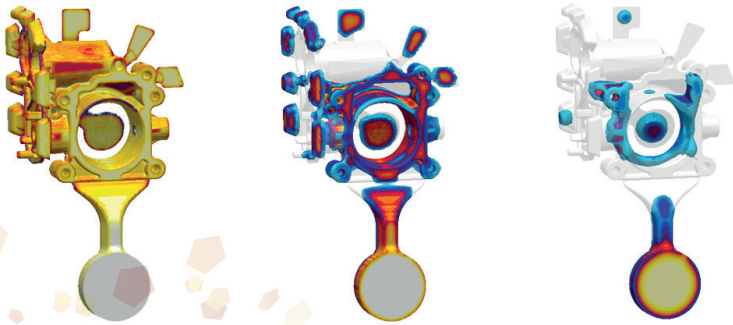
SOLIDIFICATION & COOLING

During solidification there are many factors that influence defect formation, such as: the intensification pressure, the metal treatment practice used, and the heat transfer in the casting system and die.

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

- Shrinkage porosity
- Die soldering
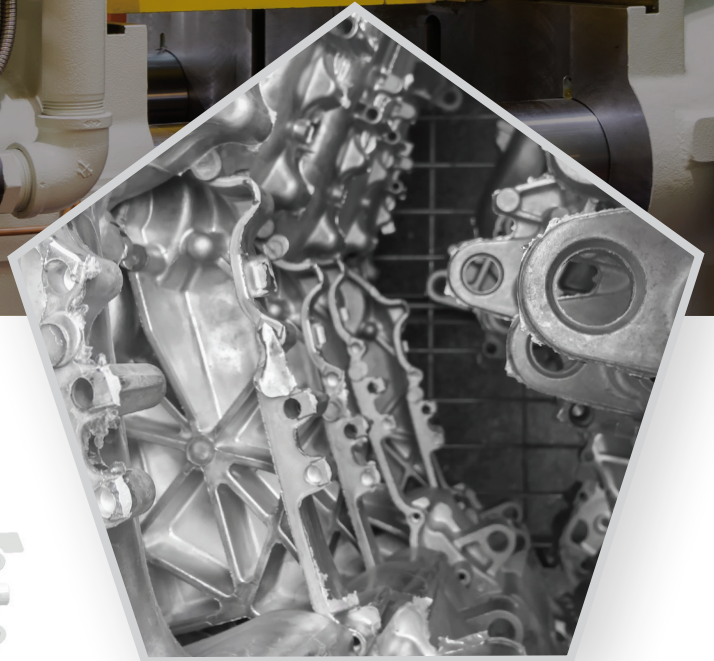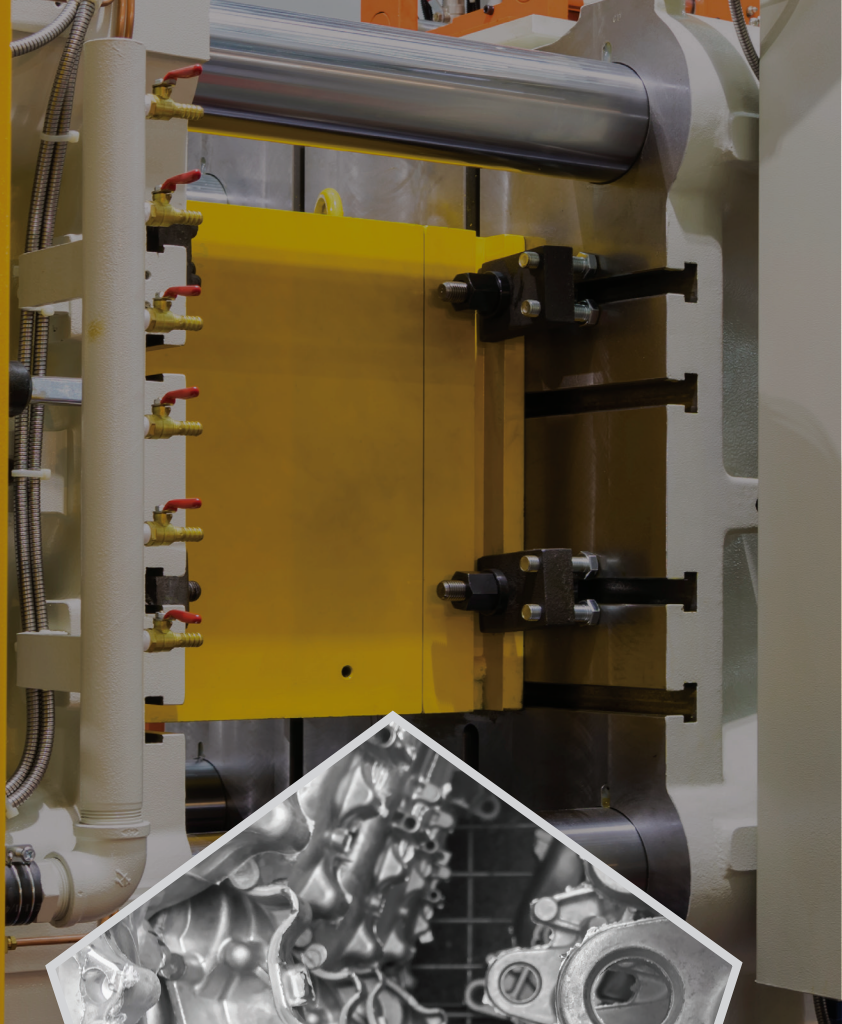
PREDICT

Metal temperatures during advancing solidification
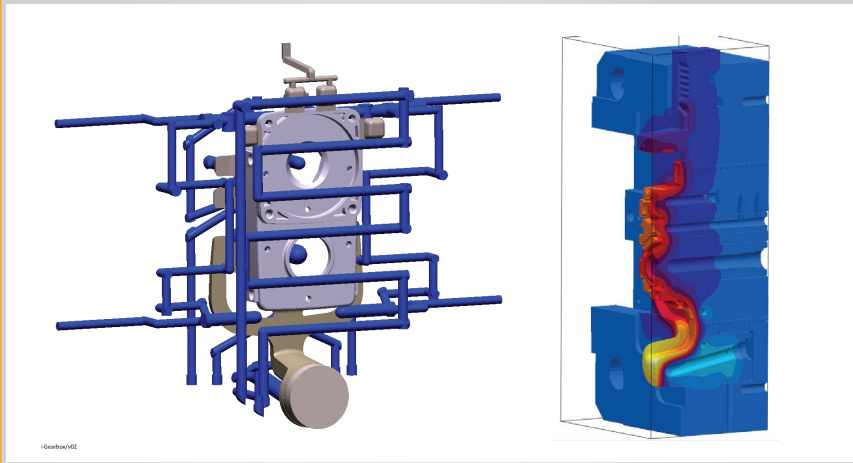
Analysis of defects

DIE THERMAL ANALYSIS

MAGMASOFT® has tools built-in to evaluate all the heat transfers in the high pressure die cast process. This accounts for:

• Any number of preheat cycles and cycle interruptions
• Internal cooling lines with flowrate and on/off controls
• Mold preparation by spraying and blowing

Local thermal conditions in the die have an influence on the solidification process of the casting

EJECTION

MAGMASOFT® has the functionality to measure the force exerted on the casting during ejection. This can help determine if the part is twisting or bending during ejection.

Von Mises
MPa

Empty
150.0
139.3
128.6
117.9
107.1
96.4
85.7
75.0
64.3
53.6
42.9
32.1
21.4
10.7
0.0
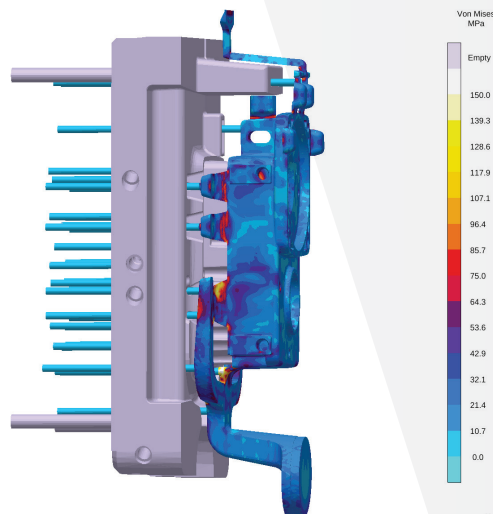
Calculate ejector forces throughout ejection time based on local contact pressures between casting and die
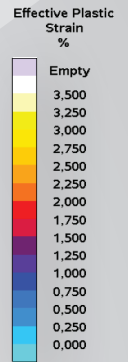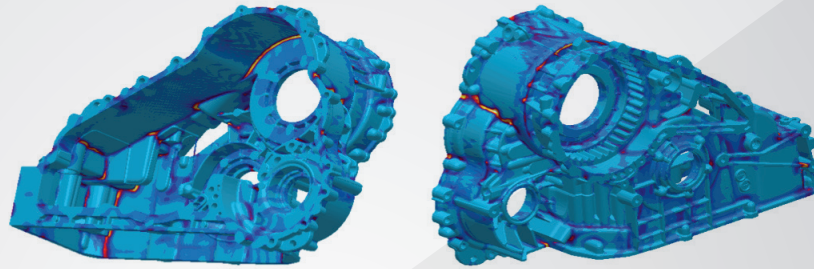
criteria

STRESS & DISTORTION

The contraction of castings during the casting and heat treatment process, along with the influence of constraints from the die can result in:

- High residual stresses
- Cold cracking and hot tears
- Excessive distortion
- Thermal imbalance

Effective Plastic Strain %

|	
Empty	
3,500	
3,250	
3,000	
2,750	
2,500	
2,250	
2,000	
1,750	
1,500	
1,250	
1,000	
0,750	
0,500	
0,250	
0,000	

Plastic strains during cooling in the die

HEAT TREATMENT

The detailed simulation of the heat treatment process is seamlessly integrated into the virtual high pressure die casting process chain evaluating:

- Thermally driven residual stresses
- Casting distortion
- Considers all process steps
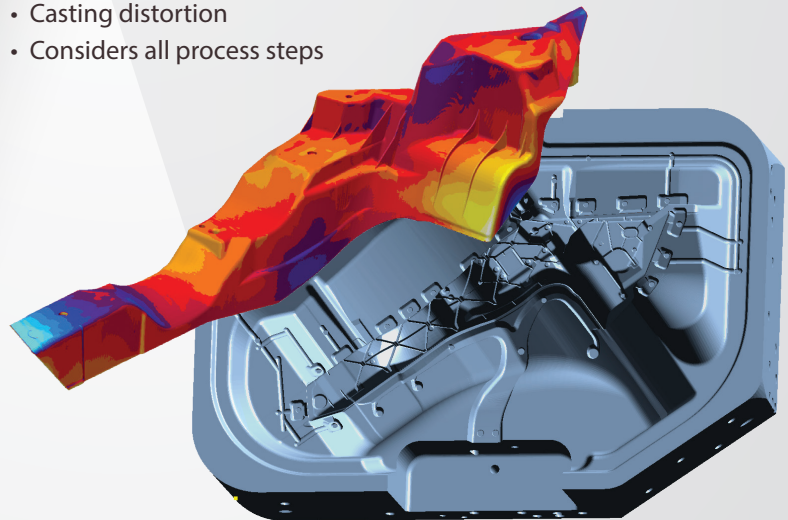
Casting distortion during the HPDC process

KEEP THE TASK
efficient

Time and engineering resources are at a premium in the die cast facility. 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 designs 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
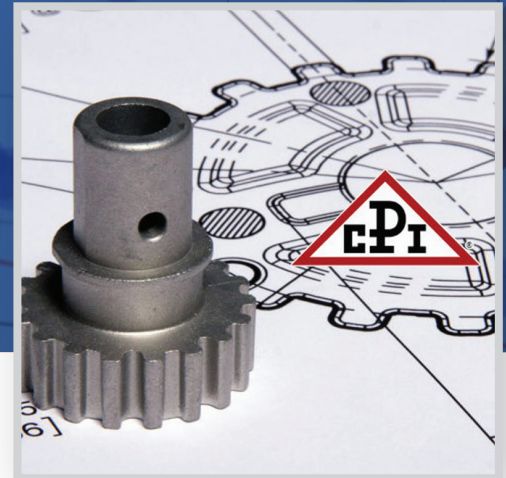
Since its adoption here at Cast Products, Inc., MAGMASOFT® has been the nucleus of a company wide shift to a "Science-based" approach to HPDC that goes far beyond simulations. From the initial casting design and quoting to trouble shooting existing parts in production, the structure and tools offered with MAGMASOFT® autonomous engineering have given us a common language to approach, discuss, and improve the quality and efficiency of our castings and tooling on a daily basis.
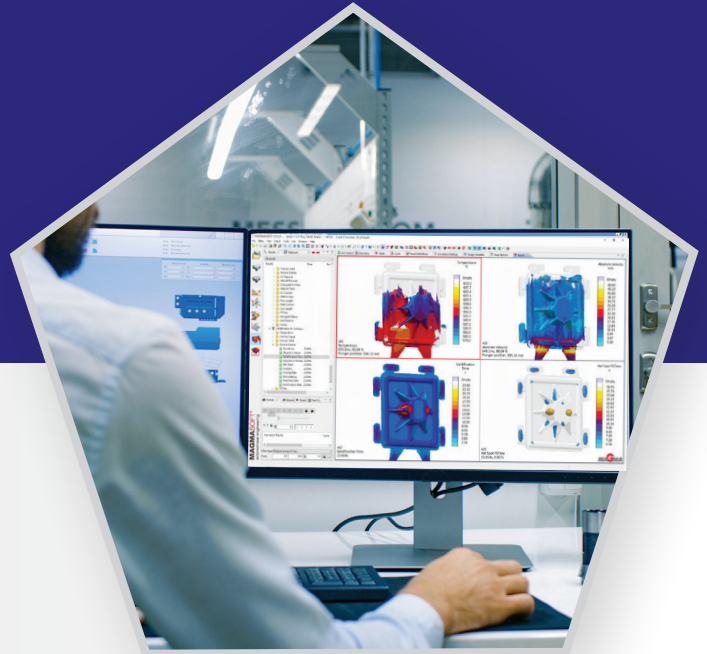
– Bill Pankiw, Process Engineer – Cast Products, Inc. Norridge, Illinois

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
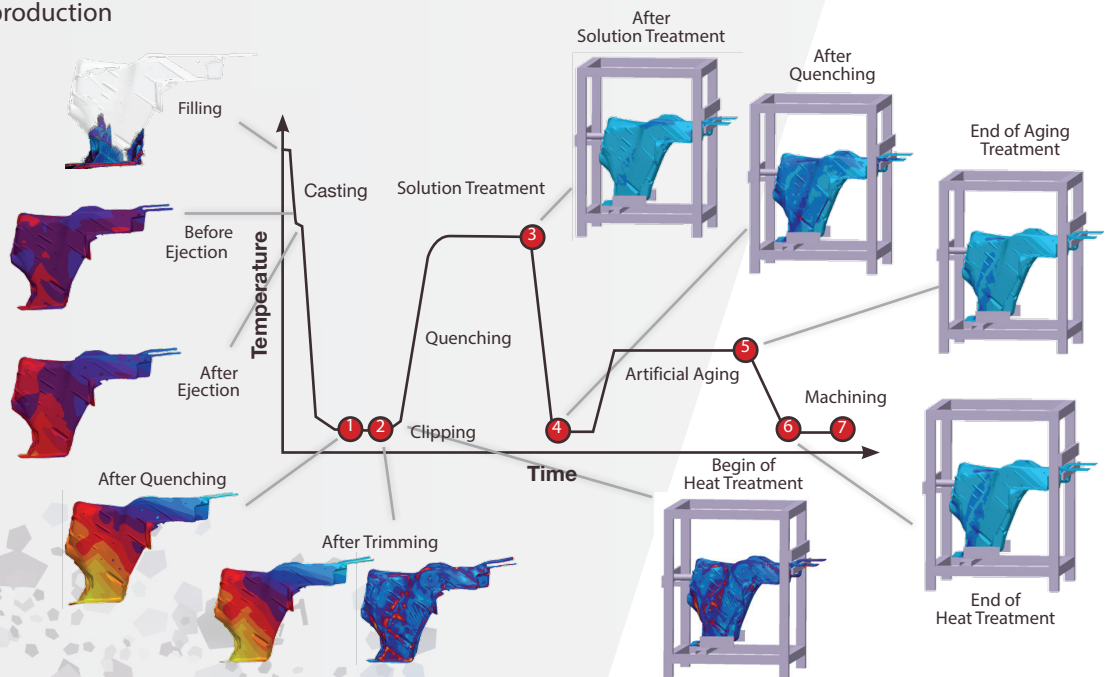
Quality improvements during different phases of new tooling development

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, engineering services 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
- Formal training

ONGOING SUPPORT

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

Our support staff is made up of metal casting experts with over 230 years of industry experience. Dedicated support engineers will work each day to make sure your organization is consistently meeting its goals, day after day, year after year.

ENGINEERING SERVICES

MAGMA project engineers are here to help you with any casting project assistance you need. You do not need to be a MAGMA customer to benefit from our Engineering Services. Each of our engineers will bring their years of experience in the metal casting industry to your project to help ensure a successful partnership between your company and ours.

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.

TRAINING
Users learn to efficiently and systematically use MAGMASOFT®.

ONLINE RESOURCES
- Webinars
- Tips & Tricks
- Video Tutorials

WORKSHOPS
Learn and practice more advanced skills, techniques and applications.

ANNUAL USER MEETING
Users learning from other users.

SEMINARS
Users and non-users gain deeper insight to organization-wide improvement strategies.

MAGMA academy

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

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MAGMASOFT®
autonomous engineering

MAGMA
Committed to Casting Excellence

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