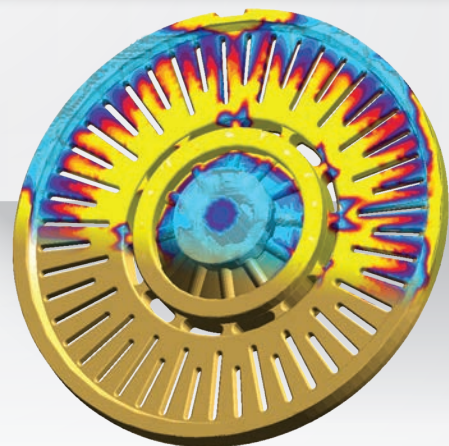


AUTONOMOUS ENGINEERING™

CORE + MOLD

- Eliminate scrapped cores before they become a reality
- Improve casting quality by improving core quality
- Balance production costs with core quality
- Quickly identify variables that impact core quality
- Consider process variability
- Consider the entire shooting and curing processes



THE **MAGMA** APPROACH



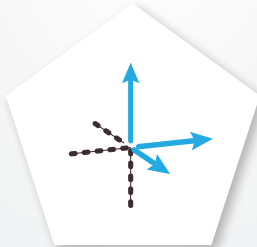
Targeted, Systematic Path to Success

Successfully navigating the highly complex core making 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

You work hard to produce quality cores, 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 core is shot or cured the potential to create defective cores exists. With every defective core 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, you need cores produced on time to make their castings on time. Castings and cores that are produced behind schedule 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 of costs on your bottom line including costs related to materials, labor, production rates and poor quality.

MAGMASOFT® C+M has helped Kohler Co. in a recent redesign of a core box to reduce the gas/purge cycle time and the gas usage needed while still producing the same quality core by optimizing the vent and blow tube locations for the core.

– Michael Budworth, Sr. CAD Project Design Analyst at Kohler Co. – Industrial Castings Group, Kohler, Wisconsin

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MAGMASOFT®
autonomous engineering



DEFINE YOUR

variables

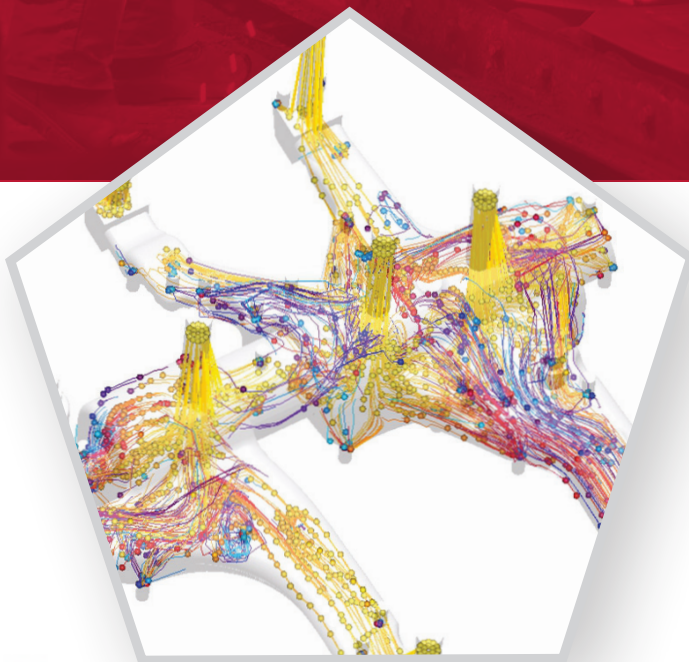
To do your job successfully, you have to understand the effects that many different variables have on the core making process. From tooling and core box design to material properties and machine parameters for the shooting and curing processes.

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

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

MATERIAL

- Sand type
- Sand grain size and distribution
- Sand density and permeability
- Gas type for cold box binder systems

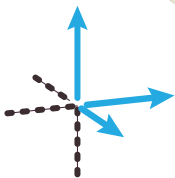


CORE BOX LAYOUT

- Vertical or horizontal parting
- Core and core print design
- Shooting nozzle shape, size and location
- Vent type, size and location
- Sand hopper size and percentage full

PROCESS PARAMETERS

- Shooting pressure
- Sand flow in nozzle and sand hopper
- Phenolic Urethane Cold Box binder systems:
 - Curing gas amount
 - Gassing time and pressure
 - Purging time and pressure
- Inorganic, shell and hot box binder systems:
 - Core and core box heating
 - Blow plate and nozzle cooling
 - Binder water percentage
 - Air temperature and pressure



SPECIFY YOUR

criteria

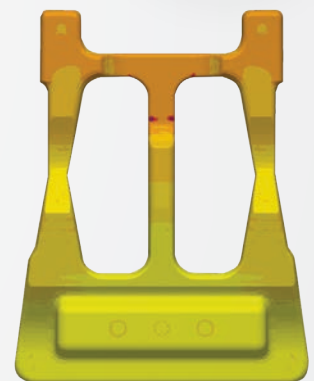
Before a problem can be solved, it must first be quantified and properly understood. MAGMASOFT® considers your entire process and provides quantitative results that measure progress.

CORE SHOOTING

When sand is shot into a core box, there are many opportunities for defects to occur. Analyzing the core shooting process using MAGMASOFT® C+M allows you to avoid defects such as lack of fill and poor sand compaction or low density areas. These core defects can lead to costly core breakage and casting defects.



Production core with poor compaction and the corresponding sand fraction result



Production core with improved sand compaction and the corresponding sand fraction result after optimizing the tooling



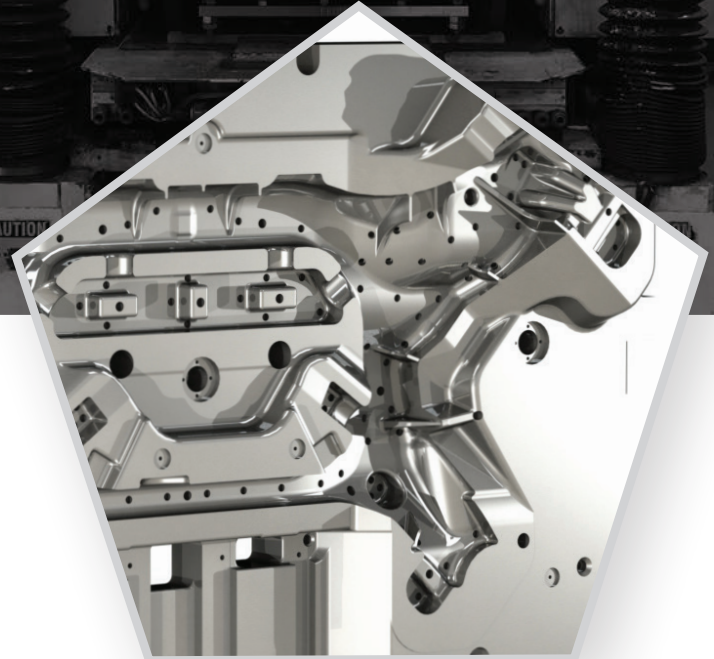
SPECIFY YOUR

criteria

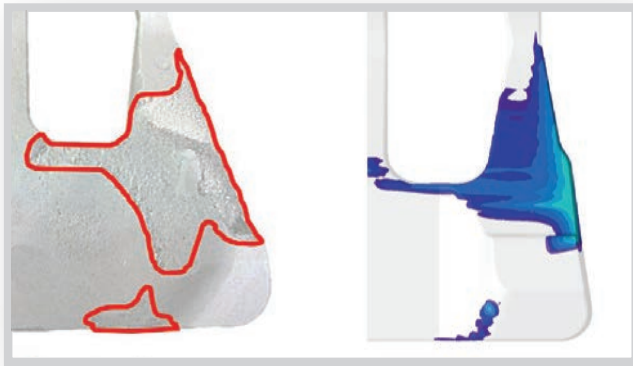
CORE GASSING: PHENOLIC URETHANE COLD BOX BINDER SYSTEM

During the gassing of cold box binder systems there are many factors that influence defect formation, such as: the type of catalyst being used (i.e. DMEA, DMPIA, TEA, CO₂, SO₂, etc.), the core box geometry, vent and gassing nozzle layout and the gassing and purging times and pressures.

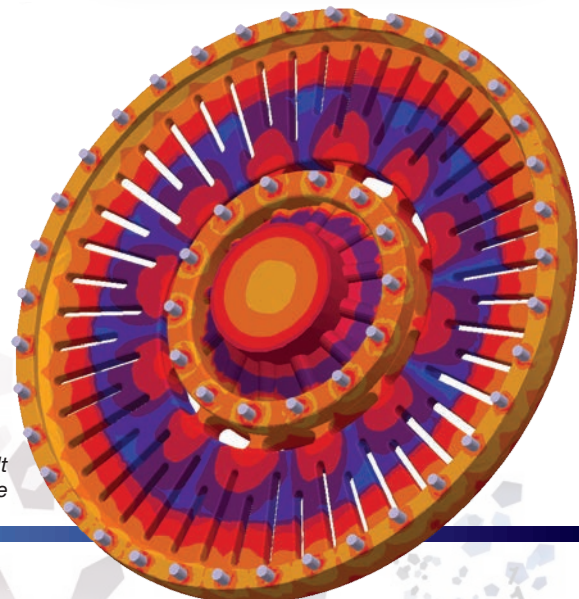
MAGMASOFT® considers each of these variables when predicting core gas flow and reaction with the binder. This allows for the prediction of uncured areas of the core and may lead to opportunities to shorten gassing cycle time and reduce catalyst usage.



PREDICT



Uncured regions of a production core are circled in red (left), areas of low binder gas adsorption are shown in blue (right)

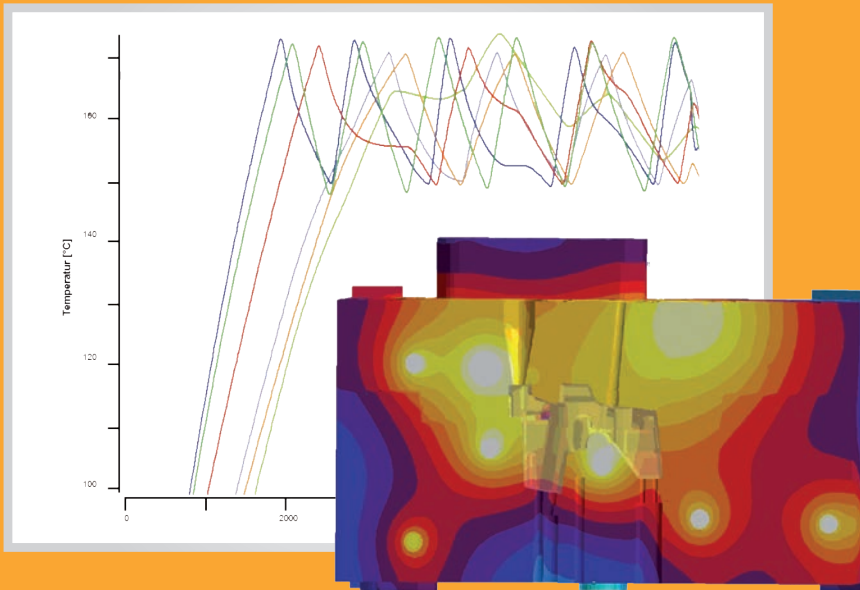


Binder gas adsorption result for a brake disc core

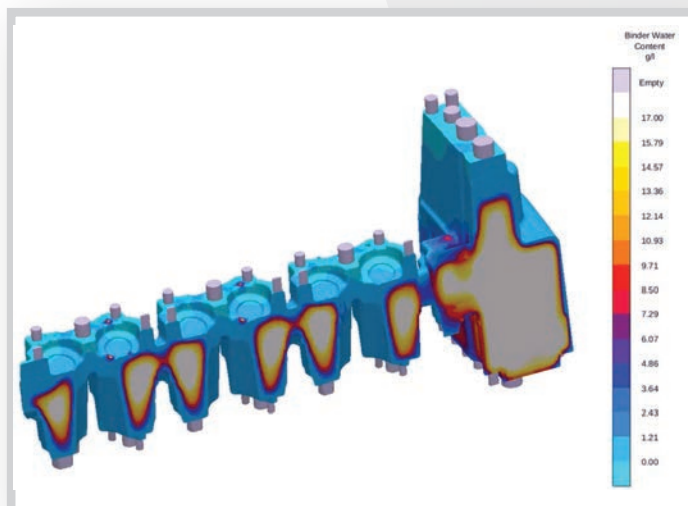


CORE CURING: INORGANIC BINDER SYSTEMS

When curing inorganic binder systems it is critical that all moisture is removed from the core in order to get the binder system fully cured. If the system is not fully cured the core will be at risk of breaking or producing gas defects during the casting process. By observing the core box heating and cooling over multiple cycles it is possible to optimize cycle times and reduce energy costs.



Temperature history at control points as well as temperature distribution in core box and core



Water content of an inorganic core during curing

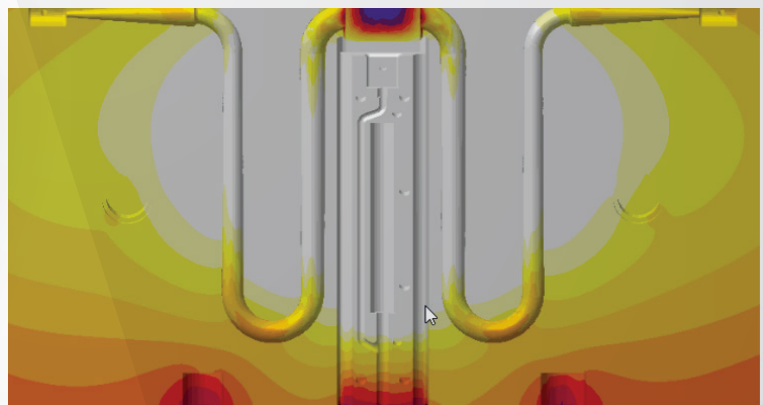
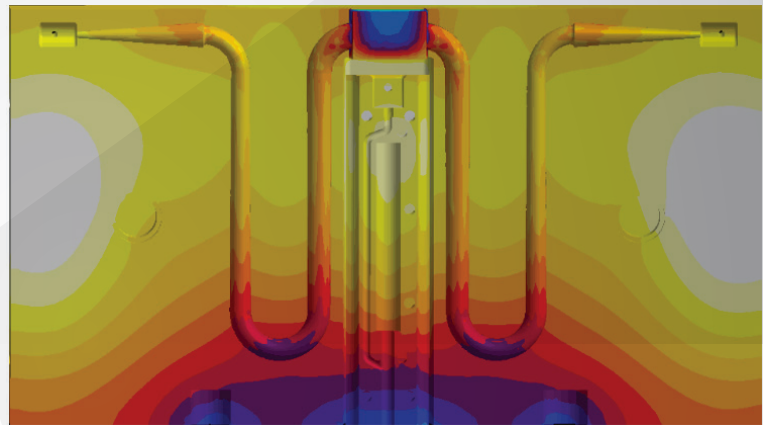


SPECIFY YOUR

criteria

CORE CURING: SHELL AND HOTBOX BINDER SYSTEMS

Shell and hotbox binder systems require all sections of the core to remain above a critical temperature for a critical amount of time. If the core is under cured it will be at risk of breaking and uncured binder may create gas defects during the casting process. Simulating the core box heating and cooling during multiple cycles allows for the optimization of heating element locations, cycle times and energy costs.



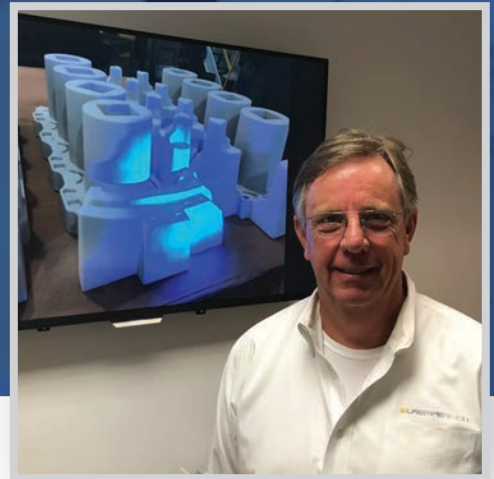
The bottom of the "U" section is not getting hot enough (top), after making modifications the entire core is getting fully heated (bottom)



KEEP THE TASK

efficient

Time and engineering resources are at a premium. 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 vents and sand types
- 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-processor 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

We extend the value of using MAGMASOFT® C+M to our prospects and customers every day and we also use it on projects in our own core production facility. The ability to simulate core shooting and curing results in faster start-ups on new jobs and increased production capacity. Additionally, we frequently use MAGMASOFT® C+M to identify the root cause of defects in very challenging legacy jobs, so that we can eliminate these defects.

– David Reich, Co-owner,
Laempe Reich Corporation, Trussville, Alabama



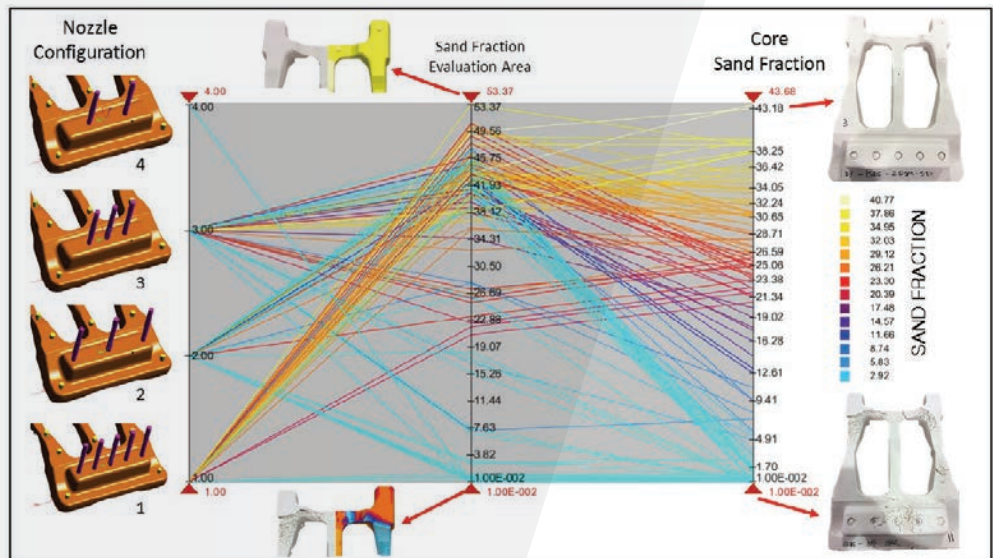
CHOOSE YOUR method

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. binder curing vs. curing gas consumption).
- Each strategic approach can be used at any stage of product life cycle including:
 - New core and core box development
 - Trouble shooting current production
 - Continuous improvement



The parallel coordinates plot shows the impact that shooting nozzle area has on the sand fraction result for this core



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.

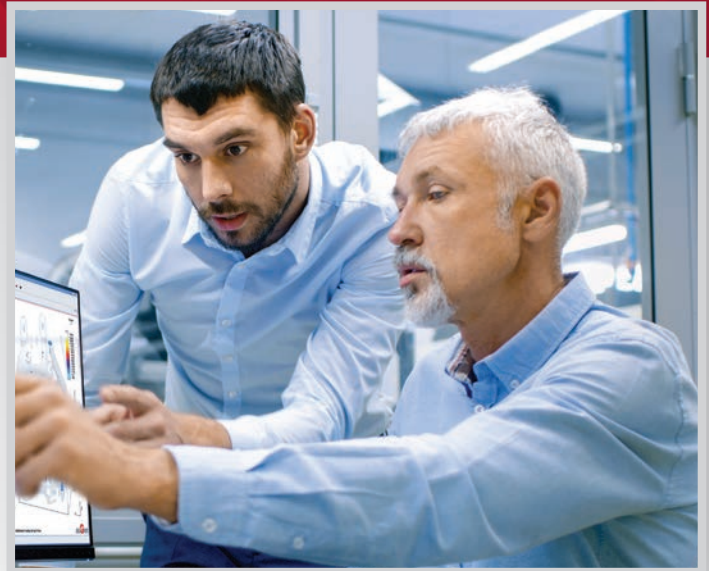
This plan covers all pertinent information for successfully launching MAGMASOFT® within your organization, including:

- 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.



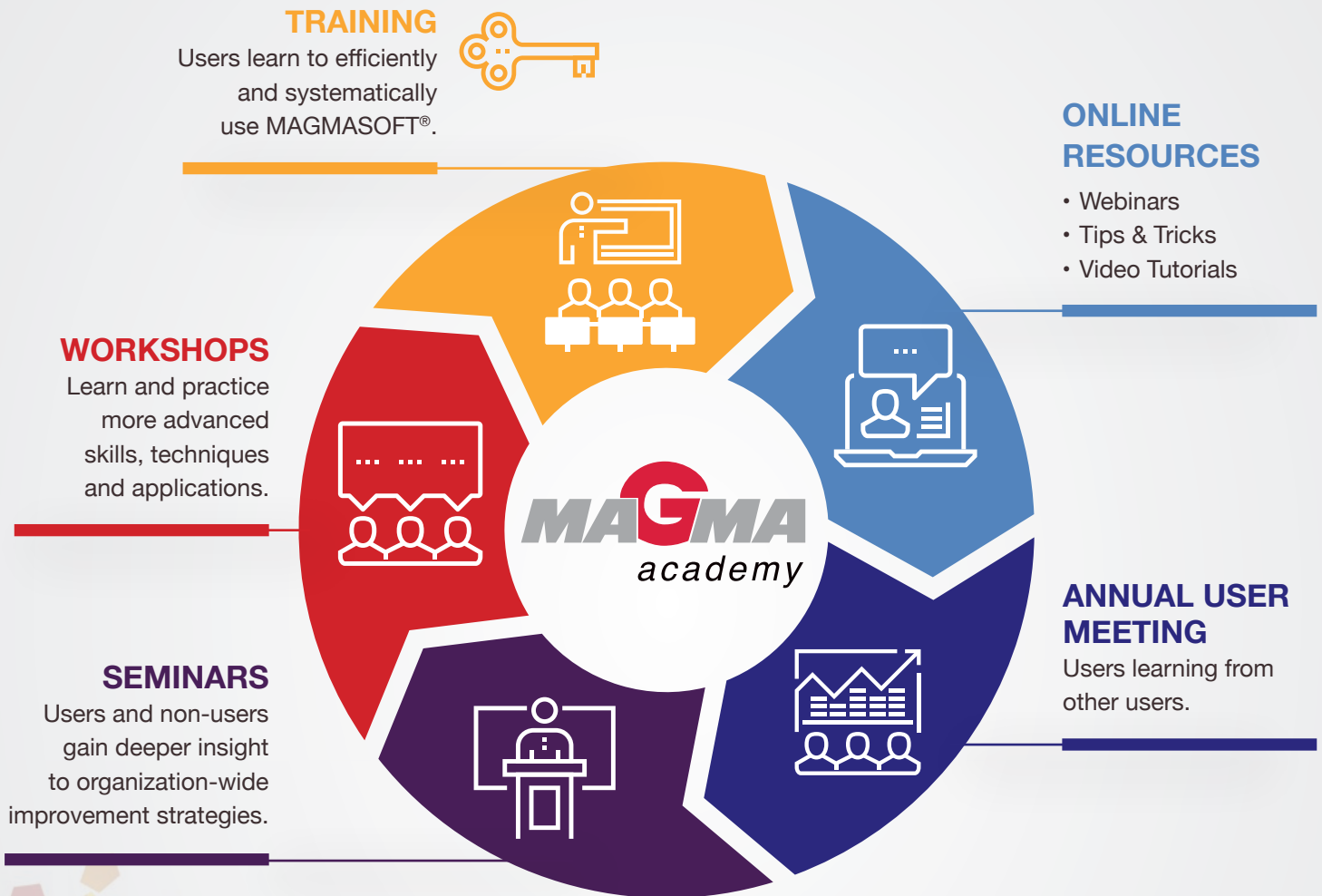
ENGINEERING SERVICES

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.



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.

5

MAGMASOFT®
autonomous engineering