get it right®

Casting Simulation Suite

ProCAST / QuikCAST

Courtesy of Fonderia Casati

ESI's Casting Simulation Suite

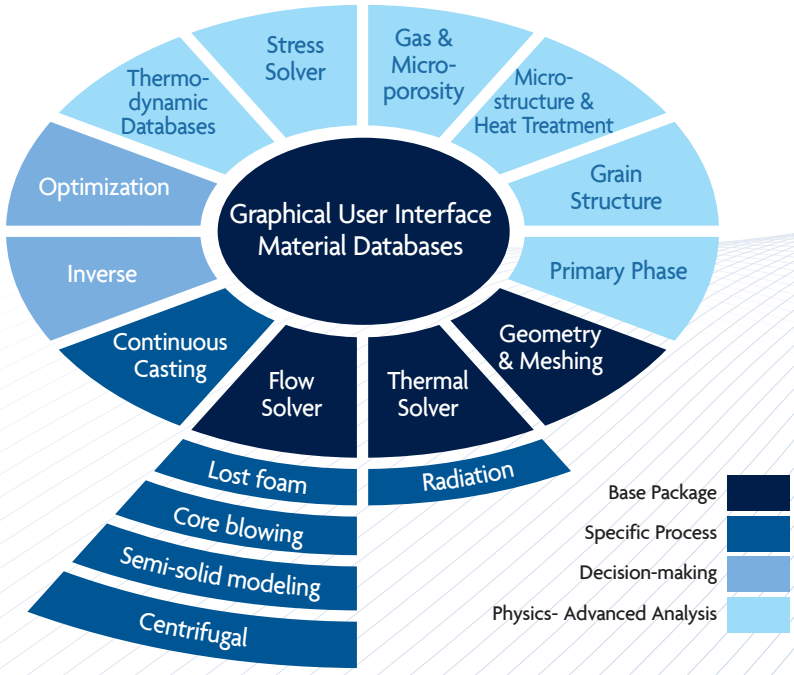
With our casting solutions, get it right the first time to enhance your productivity & profitability.

ESI offers a set of complementary applications for the foundry industry. ProCAST is an advanced and complete tool which is the result of more than **20 years of collaboration** with major industrial partners and academic institutions all over the world.

ProCAST offers an **extensive suite of modules and foundry tools** to meet your most challenging industrial requirements. The software, based on powerful Finite Element Technology, is well suited to also predict distortions and residual stresses and can address more specific processes like semi-solid, core-blowing, centrifugal, lost foam and continuous casting.

QuikCAST is a **fast and efficient** solution for the complete process evaluation. The tool addresses the basics of any casting process: filling, solidification and porosity prediction including core blowing and semi-solid modeling.

The ESI Casting Simulation Suite has proven to be an indispensable tool in the foundry to validate decisions during prototyping, to improve yield and to reduce manufacturing cost.



Modeling Casting Defects

· Solidification
- Macro Porosity
- Micro Porosity
- Gas Porosity
- Piping
- Hot Spot

· Pouring
- Misruns
- Air Entrapment
- Oxydes
- Cold Shuts
- Turbulences
- Inclusions

· Stress
- Hot Tears
- Surface Cracks
- Residual Stresses
- Cold Cracks
- Deformation
- Die Fatigue

· Metallurgy
- Stray Grain
- Freckle
- Segregation

Modeling Casting Processes

· Gravity Casting
- Sand / Permanent Mold / Tilt Pouring

· Low Pressure Die Casting

· High Pressure Die Casting

· Investment Casting

· Continuous Casting

· Centrifugal Casting

· Lost Foam

· Semi-Solid Modeling

· Core Blowing & Gassing

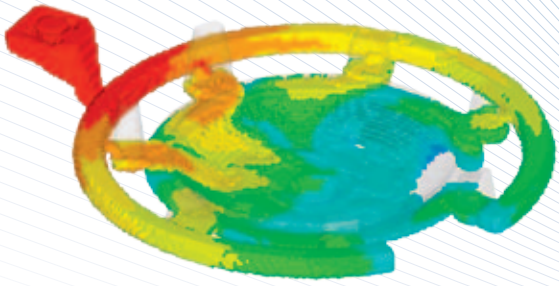
QuikCAST

Originally created by foundry professionals from Aluminum Pechiney in 1985, under the name of SIMULOR, QuikCAST provides a complete industrial solution to foundries and delivers realistic predictions at each step of the casting process. QuikCAST is an industry-specific software package which allows the user to intuitively simulate the entire casting process from filling to solidification including defects prediction.
QuikCAST allows for the simulation of complex shapes. Its validated technology is based on powerful solvers with efficient self-correction features which result in comprehensive realistic results without mesh dependence. QuikCAST has proven to be an indispensable tool in the foundry.

QuikCAST meets industrial needs

Cutting costs and reducing time to market are two of the most pressing problems for the casting industry today. QuikCAST is designed to help the user achieve these goals. It can be used at an early stage for mold and process development and also for cast part quality assessment.

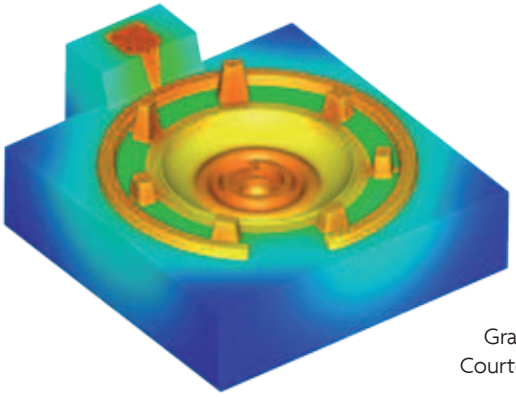
QuikCAST solves the full 3D Navier-Stokes equation coupled with the heat conservation equation. Air back pressure, filters, mold roughness, thermal exchanges, die coatings and gravity are accounted to accurately simulate most casting processes ranging from gravity sand casting to high and low pressure die casting.



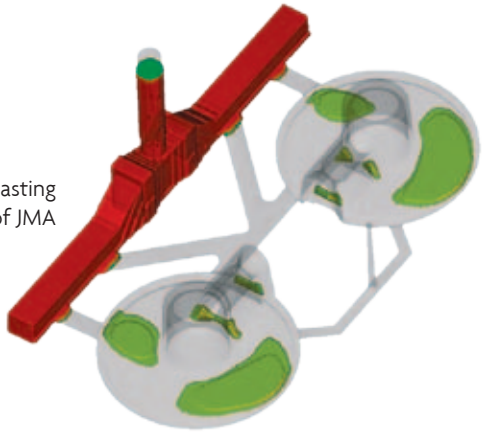
Filling-Pattern with temperature field
Courtesy of Interalloy

High-Pressure Die Casting
Courtesy of Sam Technologies

Low-Pressure Die Casting
Courtesy of Ronal



Gravity-Die Casting
Courtesy of Interalloy

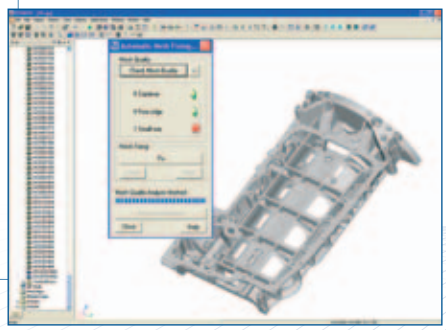


Sand Casting
Courtesy of JMA

From Quick Model Set up...

Fast automatic mold discretization from CAD

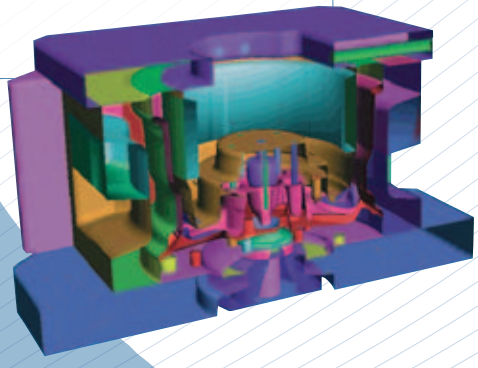
The entry point to QuikCAST is the input of the mold geometry defined as a set of STL files directly exported from the CAD software.
Efficient and automatic tools are available to quickly fix problems related to CAD model quality and to put the components in the right position.

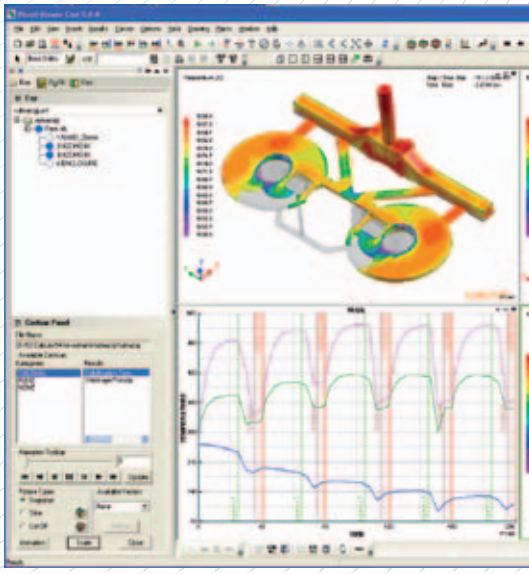


Fast automatic volume block-structured mesh generation

All separate mold components (core, risers, pouring cup's chills) are automatically assembled in QuikCAST.

An automatic volume mesh generator is provided to generate in a few minutes the block-structured mesh used for mold filling and solidification.





Simple and straightforward workflow fr

Easy numerical model definition and databases

The input data necessary to define the process is based on exhaustive information yet it is easy to set up. Hydraulic, thermal and contact conditions are defined on surfaces or volumes.
Model can be completely remeshed without losing the model set up.

Properties and parameters can be retrieved from extensive databases describing:
- Alloys (aluminum, steel, cast iron, magnesium,...)
- Mold materials (sand, cores, tool steel, ...)
- Air vents
- Die coatings

BENEFITS:

QuikCAST offers a complet
delivers realistic predictio
casting process.

QuikCAST is an easy-to-
simulation solution, enablin

- Optimize the casting proc
- Study the production fea
- Shorten lead time for mo
- Reduce trial and error
- Improve yield
- Investigate new materials
- Improve part quality

...to Fast Process Evaluation

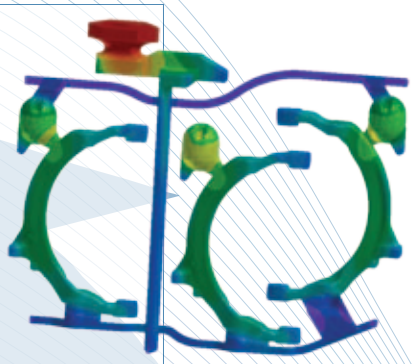
Model all your shape casting processes with QuikCAST...

Gravity casting

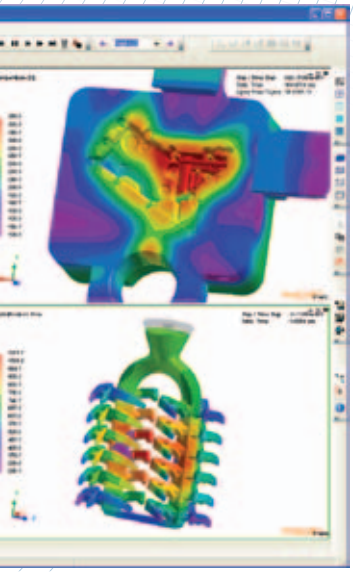
Most gravity casting processes including sand mold, permanent mold and tilt pouring can be quickly modeled with QuikCAST.

Exothermic sleeves, chills and filters (porous or extruded foam filters) are easily and automatically set up according to the process parameters.

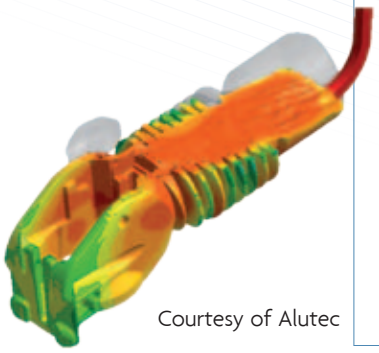
Thermal Modulus and Hot Spots results can be visualized to validate the size and the position of the risers.



Courtesy of San Eloy



om pre to post-processing



Courtesy of Alutec

Low pressure die casting

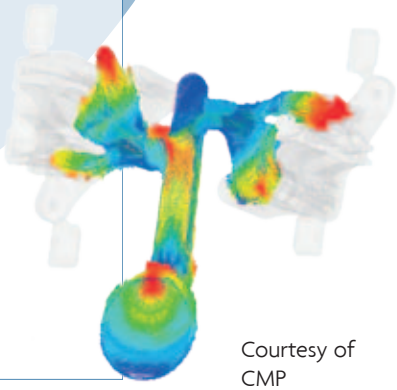
QuikCAST has a complete set of dedicated tools to model the low pressure die casting process.

During solidification simulation, the evolution of the solid fraction is calculated and used to predict shrinkage locations. Air back pressure calculations together with appropriate user-defined pressure conditions allow the simulation of vacuum casting processes.

High pressure die casting

QuikCAST allows you to perfectly simulate the piston displacement during the first phase injection as well as its influence on porosities during the third phase.

The definition of the mold cycling sequence, cooling and heating devices are automatically generated through specific menus of the user interface allowing faster pre-processing times. Advanced post-processing features like particle tracing are available to facilitate visualizing the metal flow.



Courtesy of CMP

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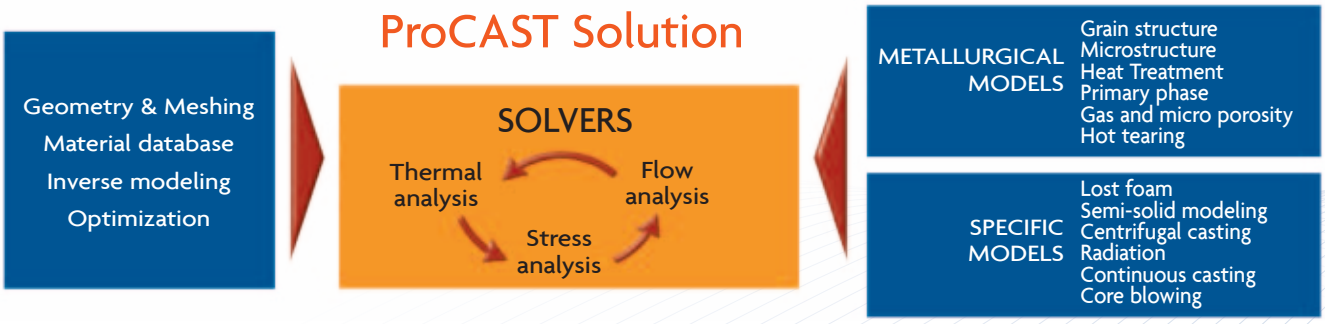
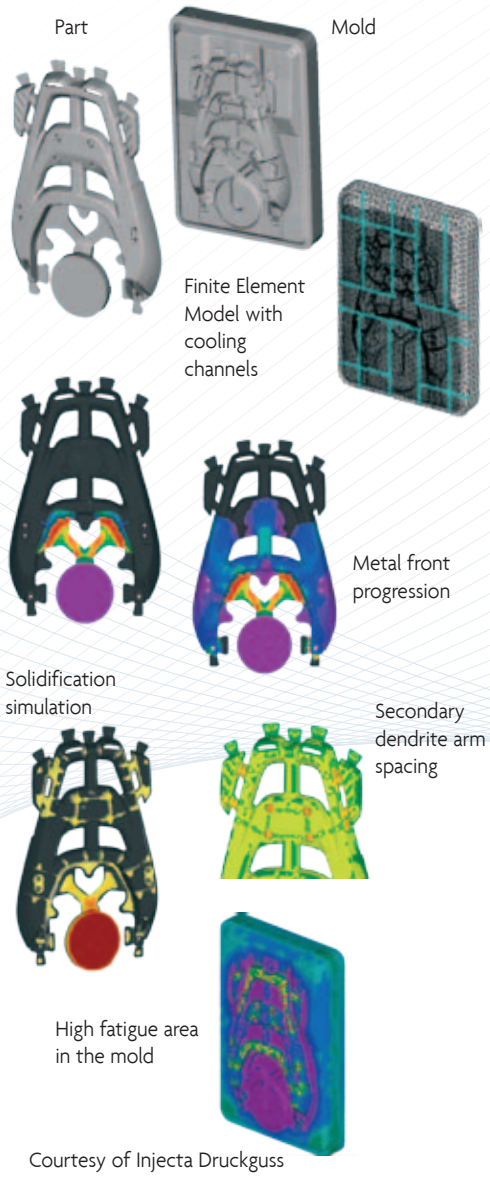
ProCAST

ProCAST is a foundry simulation software, providing coupled thermal-flow-stress analysis, along with unique metallurgical capabilities, for all your casting processes and castable alloys.



FROM MODEL SET-UP ...



Courtesy of Injecta Druckguss

... TO PROCESS VALIDATION

Geometry & meshing

ProCAST is delivered with a 3D tetrahedral mesh generator with a CAD reader and analysis tool to facilitate the link between the CAD environment and meshing operations. Available CAD interfaces are: IGES, STEP, VDA, STL, IGES, Parasolid, Unisurf, ACIS, UNIGRAPHICS, AutoCAD, CATIA v4 and v5. An automatic shell generator is included to allow the creation of shells for investment casting (including layered shells). It also includes a layered mesh option for increased accuracy and allows the generation of coincident and non-coincident meshes. Surface mesh assemblies and Boolean operations can be performed.

Flow solver

The precise geometry description provided by Finite Element models allows ProCAST to predict the metal flow inside the mold and allows for the accurate understanding of:

- Sand erosion and turbulences
- Misruns and cold shuts
- Overflow positioning
- Air entrapments, Oxyde, Material Age, Flow Length

Fluid flow calculations are described by the full Navier Stokes equation and can be coupled with thermal and stress analysis. Specific models have been added to the flow solver for the analysis of turbulent flows, thixotropic or semi-solid materials, centrifugal castings, lost foam and core blowing.

Thermal solver

The thermal solver allows the computation of heat flow by taking into account conduction, convection and radiation. The heat release associated with phase changes such as solidification and solid phase transformations is described by an enthalpy formulation. Casting issues addressed by the thermal solver include:

- Hot spots and porosity
- Die cooling and heating optimization
- Macro and micro shrinkage
- Runner and riser design

Stress solver

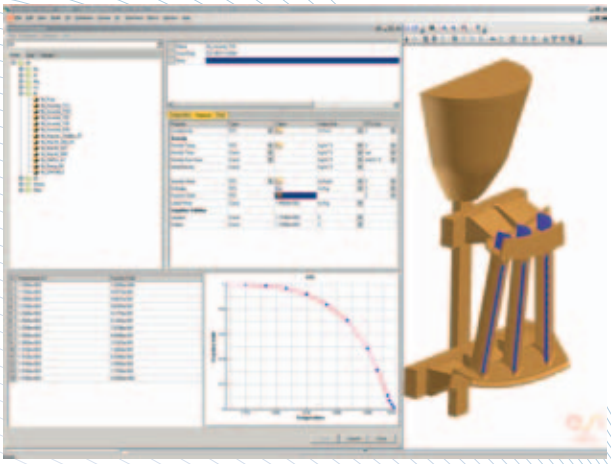
The state-of-the-art stress solver enables fully coupled thermal, fluid and stress simulations with elasto-plastic or elasto-viscoplastic material behaviors. Simpler material models such as elastic, vacant or rigid can also be taken into account. Coupled stress calculations can accurately predict:

- Thermal and mechanical contact
- Distortion and deformation
- Stresses in the casting and die
- Hot tearing and crack
- Fatigue

Comprehensive material database

An extensive material database is provided with ProCAST. This material database is continuously expanding with proven industry validated properties.

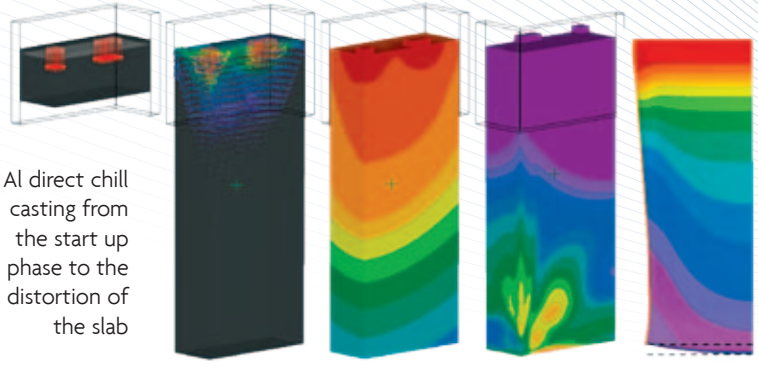
ProCAST features a **unique thermodynamic material database** calculator, which allows the user to directly enter the chemical composition of the alloy, and automatically predict temperature-dependent properties required to accurately simulate the casting process.



Material database layout and property plots

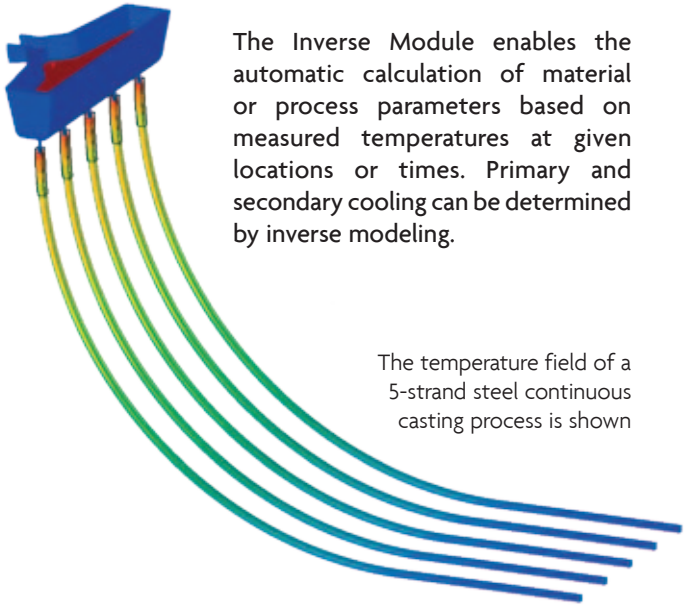
Continuous casting

ProCAST provides a complete solution for continuous and semi-continuous casting process simulation. The software can simulate steady-state conditions as well as the initial and final stages of continuous casting processes.



Al direct chill casting from the start up phase to the distortion of the slab

An application of the MiLE algorithm applied for Direct Chill casting (DC) of an Al alloy is shown (inlet design, fluid flow, thermal field, effective stress and deformation). An application of a steady-state calculation for a curved continuous casting is also shown. The first picture is colored by the temperature field while the second one shows the fraction of solid field.



The Inverse Module enables the automatic calculation of material or process parameters based on measured temperatures at given locations or times. Primary and secondary cooling can be determined by inverse modeling.

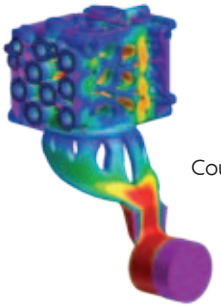
The temperature field of a 5-strand steel continuous casting process is shown

ProCAST also offers a unique capability: the User functions which allow more advanced end users to program their specific process requirements. For example User functions allow you to define boundary conditions as time, temperature and space-dependent in order to accurately model any specific casting process.

ProCAST Designed By Foundry Experts ...

High-pressure die casting

ProCAST addresses the specific needs of high pressure die casting including squeeze casting and semi-solid material processes. Achieve optimal piston velocity profiles, gating designs and overflow positioning with simulation even for very thin walled structures. Perform thermo-mechanical calculations to address not only the issue of die life but also in-service part performance, thus reducing manufacturing risks and costs.

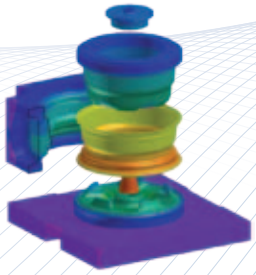


Courtesy of Alupress

Low-pressure die casting

To reproduce industrial production conditions, perform mold cycles can be performed numerically until the mold has reached steady state temperature conditions. Based on thermal die profiles, mold filling and solidification results, process parameters can be tuned to achieve optimal process quality while reducing time to market.

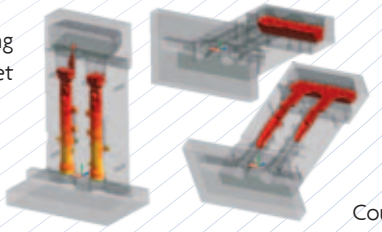
Courtesy of CMS

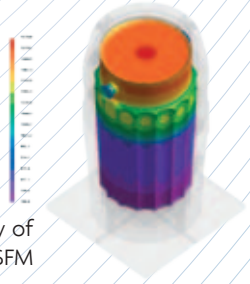


Gravity die casting and tilt pouring

Use ProCAST to simulate gravity die casting including tilt pouring processes can be simulated by ProCAST. You can freely define the axis and velocity of rotation.

Tilt pouring
Courtesy of Fomet



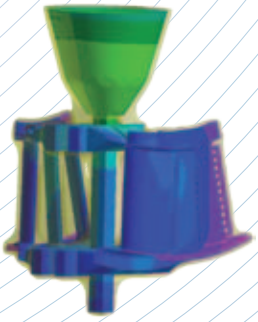


Courtesy of
Vulcan SFM

Investment casting, shell casting

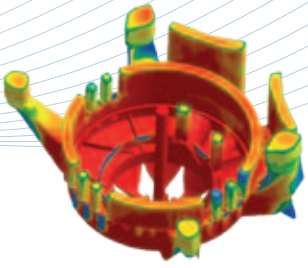
ProCAST has dedicated features to address the specific needs of investment casting foundries. For instance, you can automatically generate a mesh representing the shell mold, allowing for non-uniform thickness to be blended and multiple shell layers created. Also radiation with view factors, including shadowing effects which are critical for high temperature alloys, is taken into account.

NGV Blade with
realistic shell
modeling



Sand casting

In the gravity casting industry key success factors are optimizing the gravity casting industry are optimizing the runner system and on eliminating possible shrinkage areas. ProCAST allows for the simulation of mold filling, solidification and microstructure prediction. The location of risers and the use of insulating or exothermic sleeves and their influence on shrinkage can be studied on the computer and visualized directly on screen in order to achieve optimal part quality.



Courtesy of ZF
Aviation Technology

Porosity in cast iron

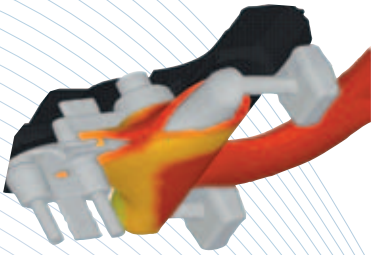
The standard porosity model of ProCAST can take into account not only shrinkage but also expansion during solidification of cast iron. Other factors such as mold rigidity can also be taken into account. A more comprehensive approach consists of running coupled thermal, microstructure and porosity calculations. The microstructure solver computes the evolution of different phases and predicts local density variations. Based on the computed densities, you can view porosity result.

Courtesy of Helwan
Iron Foundries

...to Solve Foundry Problems

Cold shuts and misruns

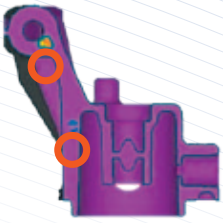
Some critical processing conditions, such as cold mold, slow filling, or low casting temperature, can lead to problems during filling. The fully coupled thermal and flow computation enables the designer to assess the temperature drop of the melt during mold filling. Premature solidification adversely influences flow behavior. By capturing these phenomena, ProCAST also predicts when and where incomplete filling or cold shuts may occur. The necessary design changes can be tested and validated, at very low cost, directly on the computer.



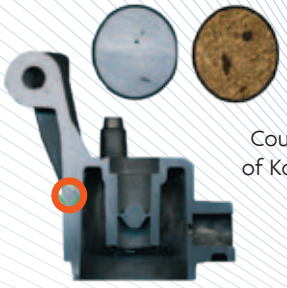
Metal front progression around a core

Porosity

Shrinkage porosity is readily addressed by the standard solver. A dedicated module is available in ProCAST to model gas porosity by accurately computing interdendritic shrinkage and taking into account gas content.



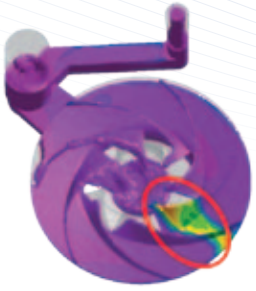
Shrinkage Porosity Prediction

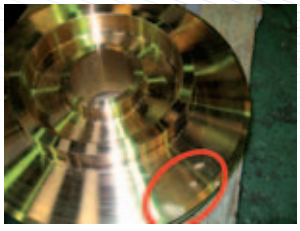


Courtesy of Kovolis

Air entrapment, Oxide Skins, Material Age, Flow Length

Air bubbles or oxide layers trapped in areas where fluid flow is restricted may locally weaken the component in service. Turbulence during filling, which may lead to oxide inclusions, is reproduced with ProCAST. The locations of such defects can be easily identified. Since it is possible to directly monitor air inclusions, ProCAST can be used to optimize the gating system and the positioning of vents and overflows in high pressure die casting.





Surface Defect Prediction

Pipe shrinkage

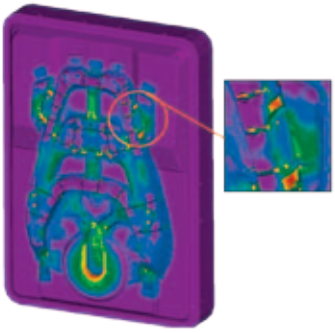
While solidification seems to proceed smoothly at the surface, large defects may appear inside the castings. For instance, when the risers do not provide sufficient feeding, large shrinkage defects such as piping may occur. With accurate shrinkage defect prediction for all types of alloys, ProCAST allows you to rapidly modify and validate the riser positioning and size.

Pipe Shrinkage prediction for a steel component

Die lifetime, hot tearing and cracks

ProCAST allows a unique coupling between thermal, flow and stress calculations. The full analysis is performed simultaneously on the same mesh. With ProCAST you can investigate the thermal shock on the tooling during mold filling as well as the influence of gap formation between the casting and the mold during solidification. Hot tears, plastic deformations, residual stresses and distortions are some of the issues which are currently investigated by our industrial customers.

High fatigue areas in the mold



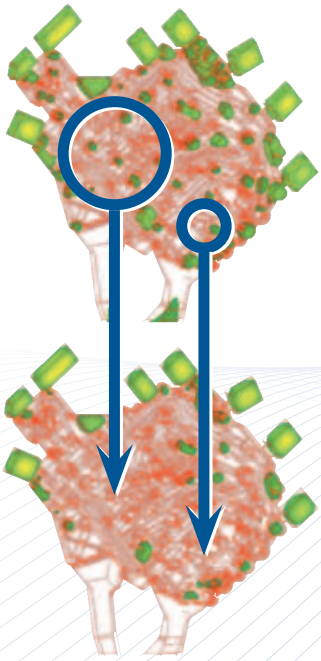
Advanced Analysis

Advanced porosity modeling

Developed in collaboration with: Assan, Doncasters, Elkem, EPFL, Hydro Aluminium, Pechiney, Rolls-Royce, Sintef, Snecma and VAW.

Most simulation solutions restrict porosity predictions to shrinkage porosity. The software essentially identifies where entrapped liquid is surrounded by solid, without considering gas porosity.

ProCAST is the first commercial software that implements a physics-based approach for the modeling of shrinkage and gas porosity. It is fully coupled with macro-porosity and pipe shrinkage predictions. The computation of the fluid flow in the mushy zone and the associated pressure drop is based on the Darcy's equation. Additionally, it includes a gas segregation model, along with the proper treatment of solubility limit and pore nucleation. This comprehensive approach extends your possibilities as foundrymen to explore and understand complex interactions between processing conditions, liquid alloy purity and porosity predictions.

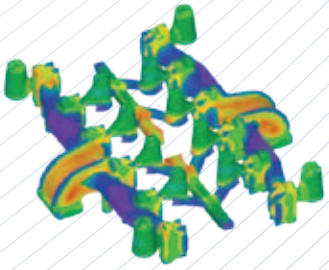


No pressure intensification
Effect of piston pressure during the compression stage on the hydrogen porosity in an aluminum high pressure die casting component

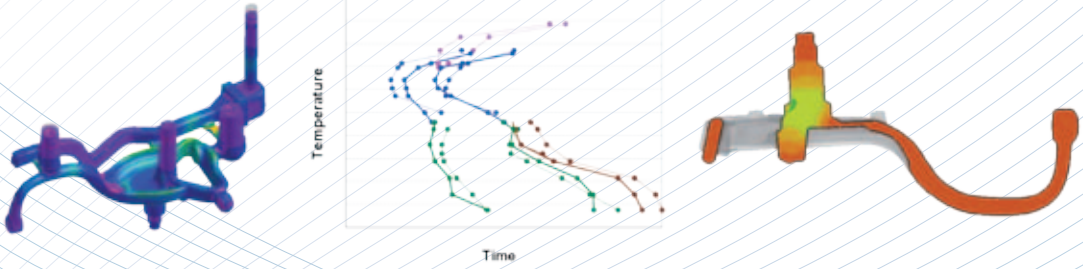
Application of pressure intensification
The reduction in gas porosity due to the increased pressure can be identified with the simulation

Microstructure modeling & mechanical properties determination

The formation of microstructures associated with solid state phase transformation during cooling or heat treatment can also be simulated with ProCAST using models based on Time-Temperature-Transformation (TTT) or Continuous Cooling-Transformation (CCT) diagrams. Mechanical properties can then be determined from the calculated microstructure.



Elongation
Courtesy of Fonderia Casati



Fraction of ferrite as cast (left) and fraction of ausferrite after heat treatment (right) of an ADI wheel carrier, courtesy of ACTech

Grain structure modeling

Developed in collaboration with: ABB, AETC, EPFL, Howmet, PCC, Rolls-Royce and Snecma.

The grain structure of as-cast components can be an important parameter that the metallurgist has to control. A typical example is the gas turbine blade, which has been solidified under directional heat flow conditions. In this investment casting process, the alloy starts to solidify at the contact with a chill under the form of very fine grains. From this equiaxed zone, the grains which have their crystallographic orientations best aligned with the heat flow direction grow preferentially at the expense of less favorably oriented grains. In the ultimate case, when a single crystal is required for extreme applications, then one grain is selected through a narrow channel under highly controlled solidification conditions. ProCAST computes the grain structure formation during solidification, which is used by many high-end industries to control casting conditions and optimize component performances. ProCAST couples a Cellular Automaton (CA) model with the Finite Element (FE) heat flow computations. For this reason, the grain structure module of ProCAST is often referred to as the CAFE module by industry experts.

Prediction of stray crystals in SX part

Grain Structure in Continuous Casting

What does Optimization Mean for Casting?

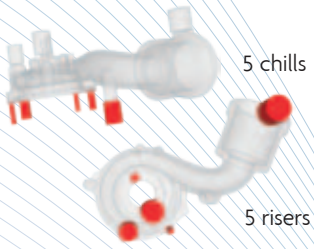
Find automatically the best conditions (design and/or process) to reach a defined goal (minimize shrinkage, improve yield, etc...) without having to make decisions after each simulation.

Design Optimization

Visual-OPT finds automatically the best design for:

· Riser locations & dimensions
· Chill locations
· Ingate positions
· Runner dimensions
· ...

Automatically define riser and chill locations/ dimensions to prevent porosity formation



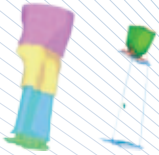
Process Optimization

Visual-OPT finds automatically the best process parameters such as:

· Pouring temperature
· Pouring rate
· Die temperature
· ...

Initial wrapping design (left) and associated porosity (right)

Is there a better wrapping configuration preventing or reducing the porosity formation in the blade ?



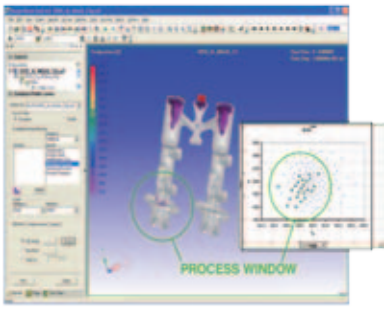
Final wrap configuration (left) minimizing porosity formation (right)

For such user-defined objectives as minimizing porosity, improving die-life, minimizing oxides, avoiding air entrapment in the shot chamber, etc...

Visual-OPT automates the costly, time-consuming trial and error process of design and manufacturing optimization.

Process Stability and Design of Experiment

The foundryman you have the possibility to evaluate the robustness of yours process as a function of different parameters such as, for instance, the pouring metal temperature or the die temperature This optimization application will automatically run a minimum number of calculations (based on a stochastic approach) to estimate the porosity risks in function of a possible deviation of these parameters. By using this capability of Visual-OPT, the user can, for example, define the safest parameter values according to the porosity sensitivity of the component.



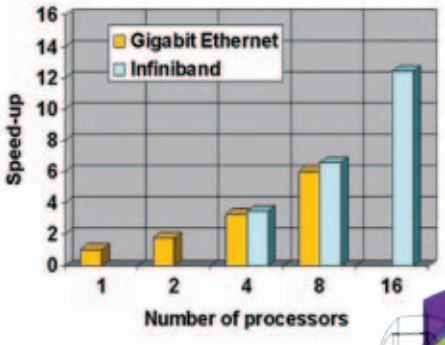
The process window shows when desired conditions are satisfied:

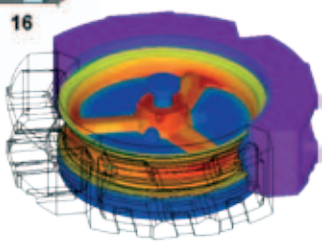
- The **average** porosity is less or equal to the value obtained under the reference conditions
- The **maximum** local porosity is also less or equal to the value obtained under the reference conditions.

Parallel processing

Both foundry simulation solutions ProCAST and QuikCAST can run jobs in parallel processing. The ProCAST DMP solution (Distributed Memory Parallel) uses the latest available technology, in particular dynamic domain decomposition and message passing communication. Available on Linux and Windows platforms (32 and 64 bits), the DMP version includes the main software functionalities to simulate mold filling, solidification with radiation, stress calculations and microstructure computations.

To reproduce industrial conditions in die casting, thermal cycles are performed to reach steady state temperatures. While a traditional 1 processor configuration allows the user to simulate 4 complete die cycles in two and half hours, a more powerful configuration with up to 16 processors and Infiniband interconnect will give the same result in 18 minutes!

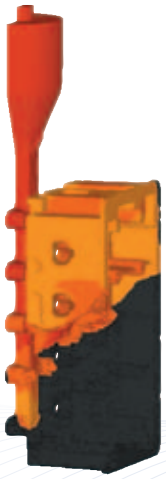




Other Processes...

Lost foam

The solution includes features that take into account the heat transfer between the liquid metal and the foam, the liquefaction and pyrolysis of the foam pattern, the transportation of gas products, the influence of the ceramic coating and the effect of the trapped gas on the movement of the liquid metal.



Courtesy of Montupet

Semi-solid modeling

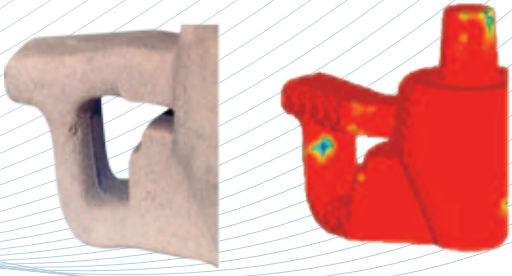
When a semi-solid material is injected in a mold cavity, it viscosity depends on the shear rate as well as the shear rate encountered by the metal previously during the injection. When the shear rate is high, the solidifying dendrites are broken and the fluidity increases (i.e. the viscosity decreases). In order to account for such a behavior, this specific module is used.

Courtesy of CSIR

Core blowing

Developed in collaboration with: Ashland, CTI, CTIF, IMFT, Infun, Laempe, Teksid and Weir Foundries.

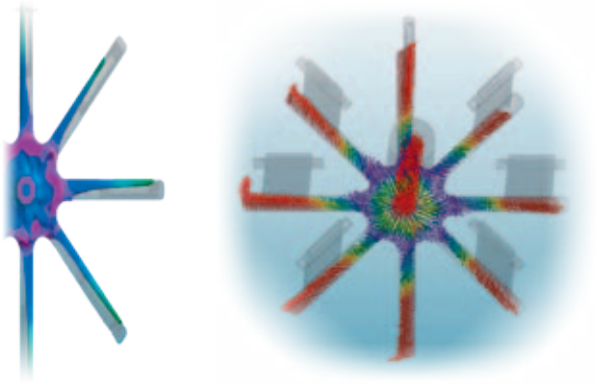
The European Commission financed during four years a research project aimed at modeling core blowing and gassing. As a result, The core blowing module accurately predicts blowing and gassing defects, including incomplete fills, low compaction and poorly hardened areas.



Details showing unfilled or poorly compacted areas Courtesy of Infun

Centrifugal casting

ProCAST has the capacity to model centrifugal casting: a shape casting mold is rotated at high speed about its vertical axis as the metal is poured. The fluid flow equation is solved in a relative (rotating) velocity reference frame.

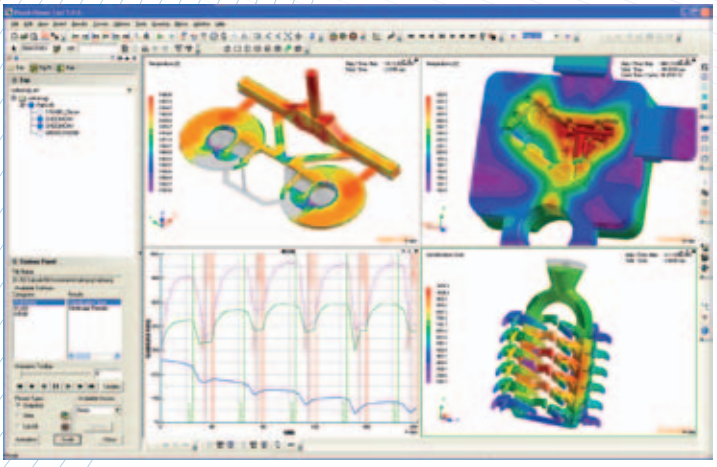


Streamlined and Productive Environment

Visual-Environment

ESI's foundry solution offers a post-processing tool fully integrated in an open collaborative engineering environment. Visual-Environment is an integrated suite of solutions providing within a single graphical user interface access to multiple applications in different simulation disciplines. ProCAST and QuikCAST, and the corresponding geometrical tools, are part of this single unified environment allowing interoperability and chaining between both casting software and other simulation disciplines.

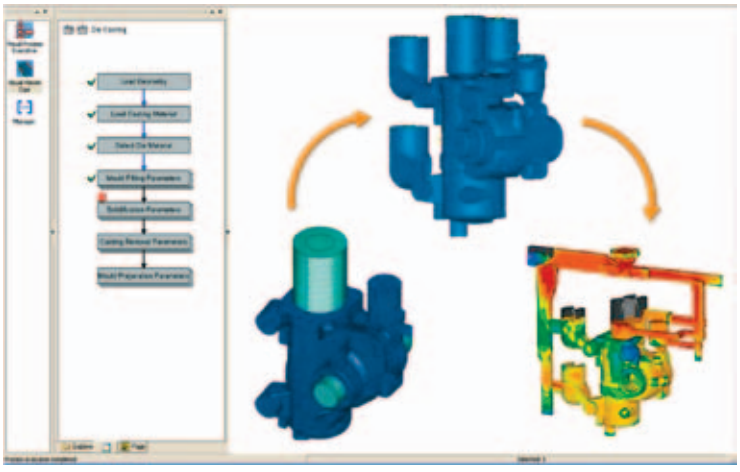
The viewer of Visual-CAST is a complete, productive and innovative post processing environment for foundry applications. It's a state-of-the-art plotting and animation control solution. With Visual-Viewer, boost the productivity of your foundry engineers by performing automated tasks and generating customized reports within a multi page/window environment.



New viewer with multi-window and multi-studies capability including a new smooth surface rendering.

Visual-Process

Preparing a simulation model for process evaluation is often a time consuming task. Using Visual-Process, advanced CAE environment for process customization and automation, engineers gain productivity and save time on modeling. Visual-Process simplifies and automates repetitive tasks by process guidance approach. The process templates customize any procedure and capture best practices.



Courtesy of Ashland & Betsaide & Inasmet

KEY FEATURES

Visual-Environment

- Windows look and feel intuitive interface
- Multi-model, multi-page, multi-plot environment
- Model manipulation tools
- Interactive slicing, scanning and X–ray viewing modes
- Contour, cut off and vector display of simulation results
- Results animations
- Particle tracing
- Curve plotting functionalities
- Flexible switching between pre-post processing solutions
- Results and geometry export functionalities
- Image and movie output for reporting and communication
- Automatic report generation in PDF and Powerpoint format
- Support of session files (scripts)

Visual-Process

- Process guidance approach to build simulation model step by step from start to finish
- Standarde modeling methodologies
- Capture best practices
- Automate repetitive model building
- Shorten the investigation of various scenarios
- Fully automatic model creation and report generation
- Reduce errors that occur in routine simulation tasks
- Reliable and consistent modeling

Consulting Services, Training and Support

Training Services

ESI training courses are provided by highly skilled engineers responsible for consulting and support activities, with years of practice and field experience. Training services are delivered to our customers using all modern techniques, either via standard training sessions as defined in our course catalogue or via customized training that answers to specific needs, including long-term training for rosters of new hires. The courses address software usage and extend to industrial problem-solving.

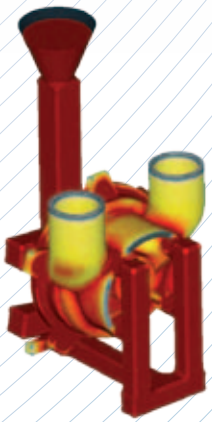
Support Services

From worldwide on-site contracting to technical assistance and our daily hotline, ESI's engineers help you achieve better and faster results in casting simulation.

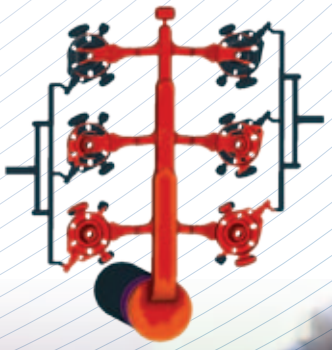
Consulting Services

Through a wide range of engineering services, ESI delivers Simulation-Based Design solutions to support our customers' needs for performance and innovation.

- Co-funded Research & Development projects or consortia with academic and industrial partners to drive innovation in simulation technology
- Joint Methodology Projects in order to validate specific simulation processes by transferring know-how to the industry
- Process Automation and Integration to optimize the customer CAE workflow and significantly improve quality and synchronization within the Product Lifecycle Management (PLM) process.
- On-Demand Projects for immediate availability for fast problem solving



Courtesy of Microcast



Courtesy of Kovolis

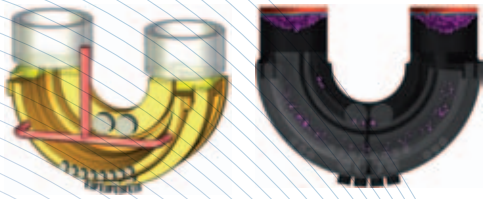
For further information, please visit www.esi-group.com/services or send us a mail at engineeringservices@esi-group.com

Selected Customer Statements

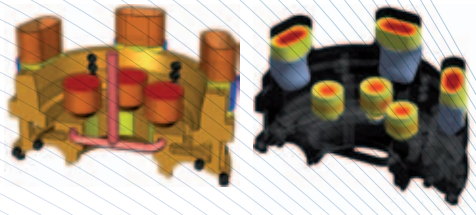
“ The objective of DSB EURO s.r.o. is to satisfy the requirements of our customers regarding the quality of our products at the highest level. ProCAST helps us not only enhance the quality of our castings but also ensure a better competitiveness. Using ProCAST enables us to deliver castings on time and to cut down unnecessary and repeated rework operations.
Finally, thanks to ProCAST we received the “European Quality Award” in 2008 which opens us opportunities for new cooperation.”

Ing. Pavel Veselý, Production Director, DSB EURO s.r.o.

Initial design with shrinkage porosity prediction

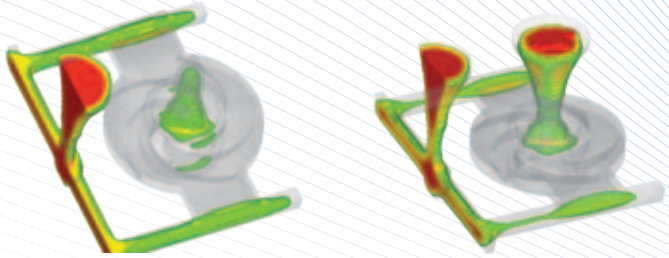


Final design after 5 iterations showing no more hot spot in the part.



“ This problem would have taken about 12 weeks and $6,000 in pattern changes plus countless hours of machine time to solve using conventional trial and error methods. With QuikCAST, we can easily solve similar problems in 2 weeks and produce a good pattern the first time. We have used simulation on about 20 parts to date and the simulation results are similar to what we see in the shop.”

Dan Rudolph, Quality Engineer, J. Walter Miller Company.

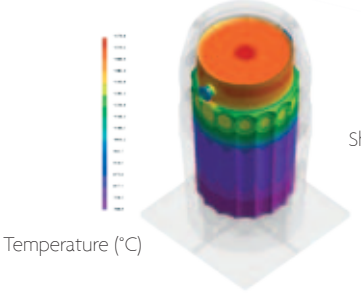


Closed riser and cored hub design. Shrink pocket shown in wear ring.

Open riser, solid hub design. No shrink pocket in wear ring.

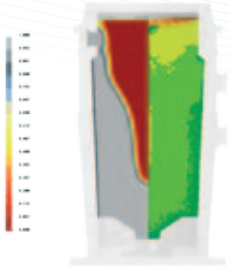
“ Using ProCAST software, Sheffield Forgemasters International (SFIL), was able to analyse several virtual scenarios before delivering a “right first time” ingot casting. After forging it to produce the final roll shape and NDT testing, it was evident that this was the highest integrity ingot ever produced at SFIL.”

Jesus Talamantes-Silva, R & D Manager, Vulcan SFM.



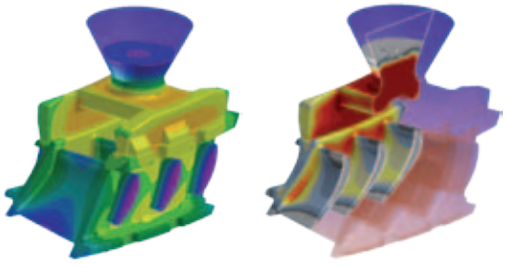
Temperature (°C)

Fraction of Solid on the left and Shrinkage Porosity on the right



“ When you have the right tool in your hands, you can easily get quick and optimal solutions arising from extremely complex problems in superalloy foundry. ProCAST does have the potential to do this. ”

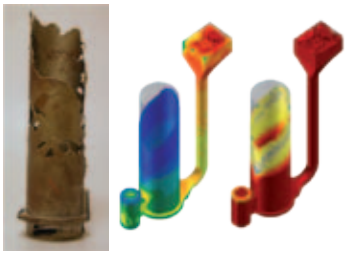
Ciro Caramiello, PhD - Process Modelling, EMA Rolls Royce



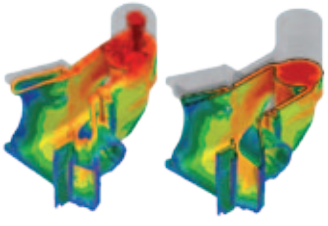
Temperature contours and fraction of solid

“ During this project we used ProCAST software and that gave us the possibility to simulate & optimize thin walled steel castings. ProCAST is a very competent software, when it comes to simulate thin walled geometries.”

Per Ytterell, Managing Director, Smålands Stålgjuteri AB, Sweden.



Trial run of partially filled prototype casting vs. Simulation results showing favorable correlation.



Simulation results of thin walled industrial steel part