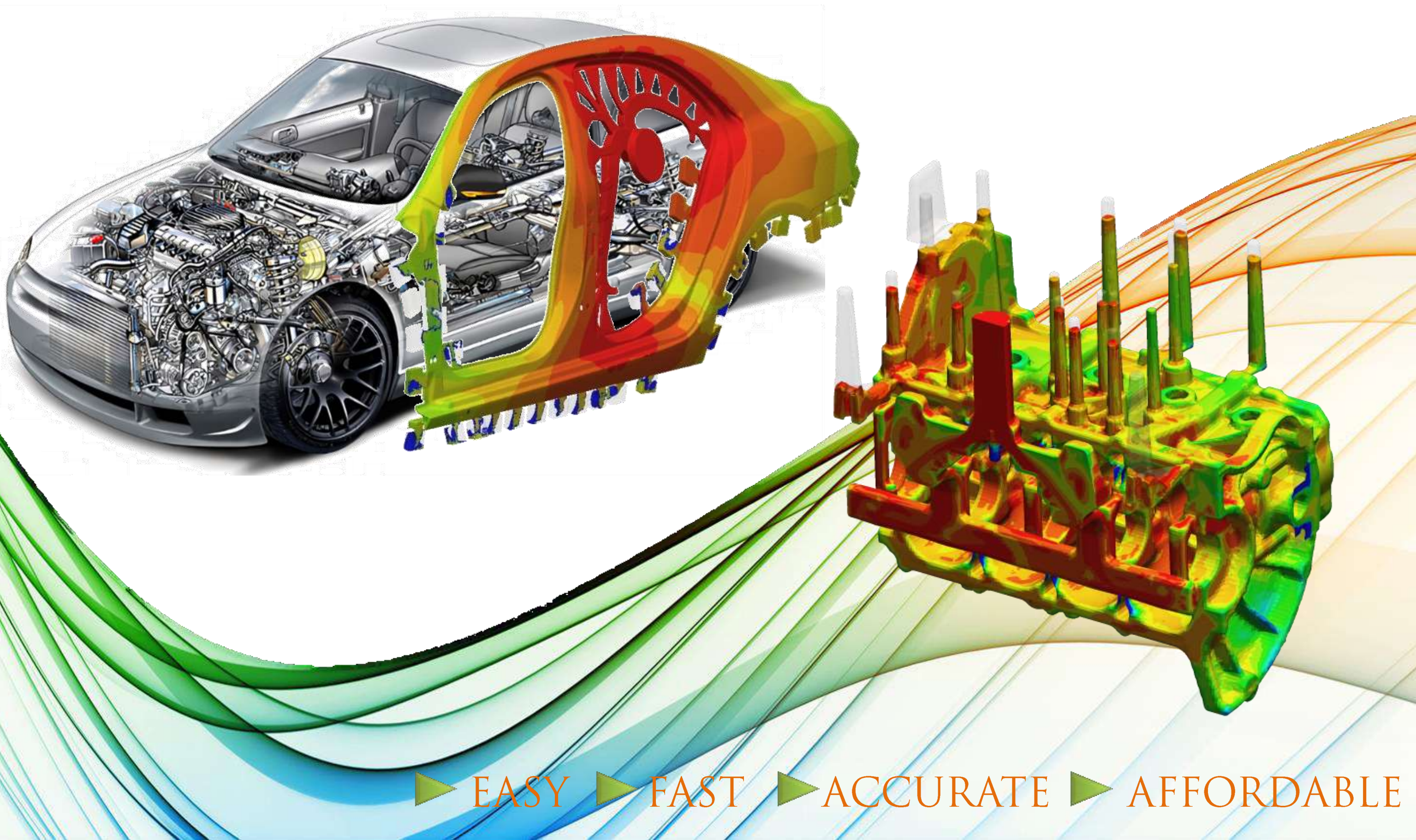


CAST-DESIGNER

END TO END SOLUTION FOR CASTING BUSINESS

ADVANCED CFD BASED CASTING SIMULATION SOFTWARE

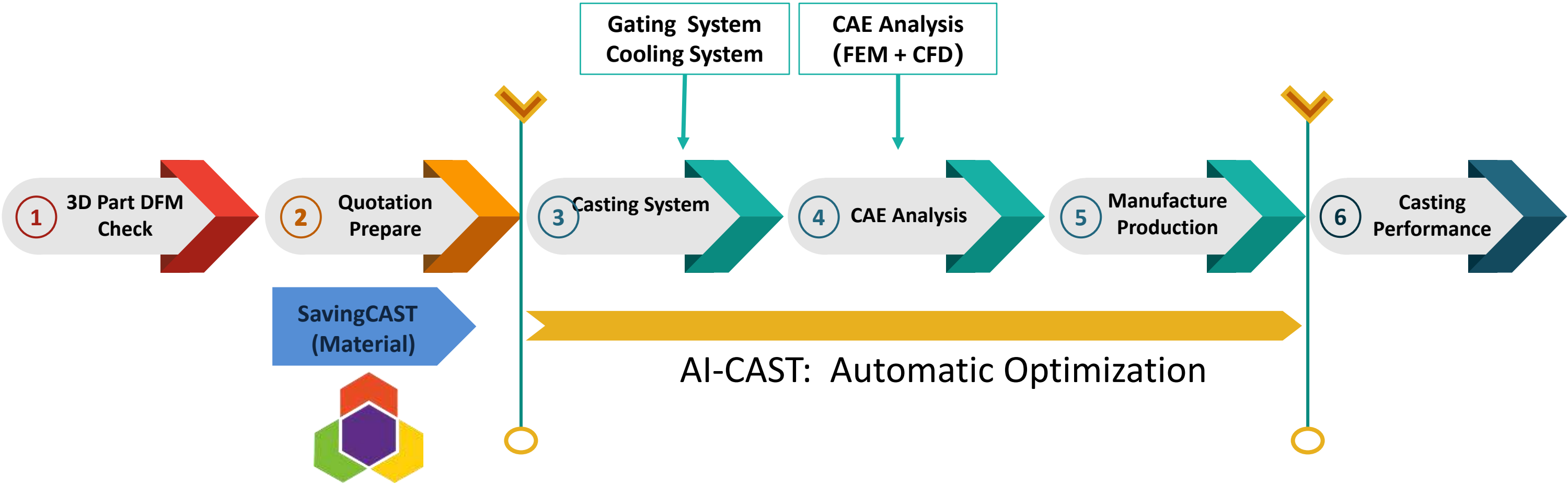
- ▶ MATERIAL ▶ DFM ▶ QUOTATION ▶ GATING DESIGN
- ▶ THERMAL-FLOW & SOLIDIFICATION ▶ MICROSTRUCTURE
- ▶ STRESS-STRAIN & DISTORTION ▶ CASTING PRODUCTION
- ▶ CASTING PERFORMANCE ▶ DOE ▶ FULL CAD DRIVEN
PART-GATING-PROCESS-PRODUCTION OPTIMIZATION



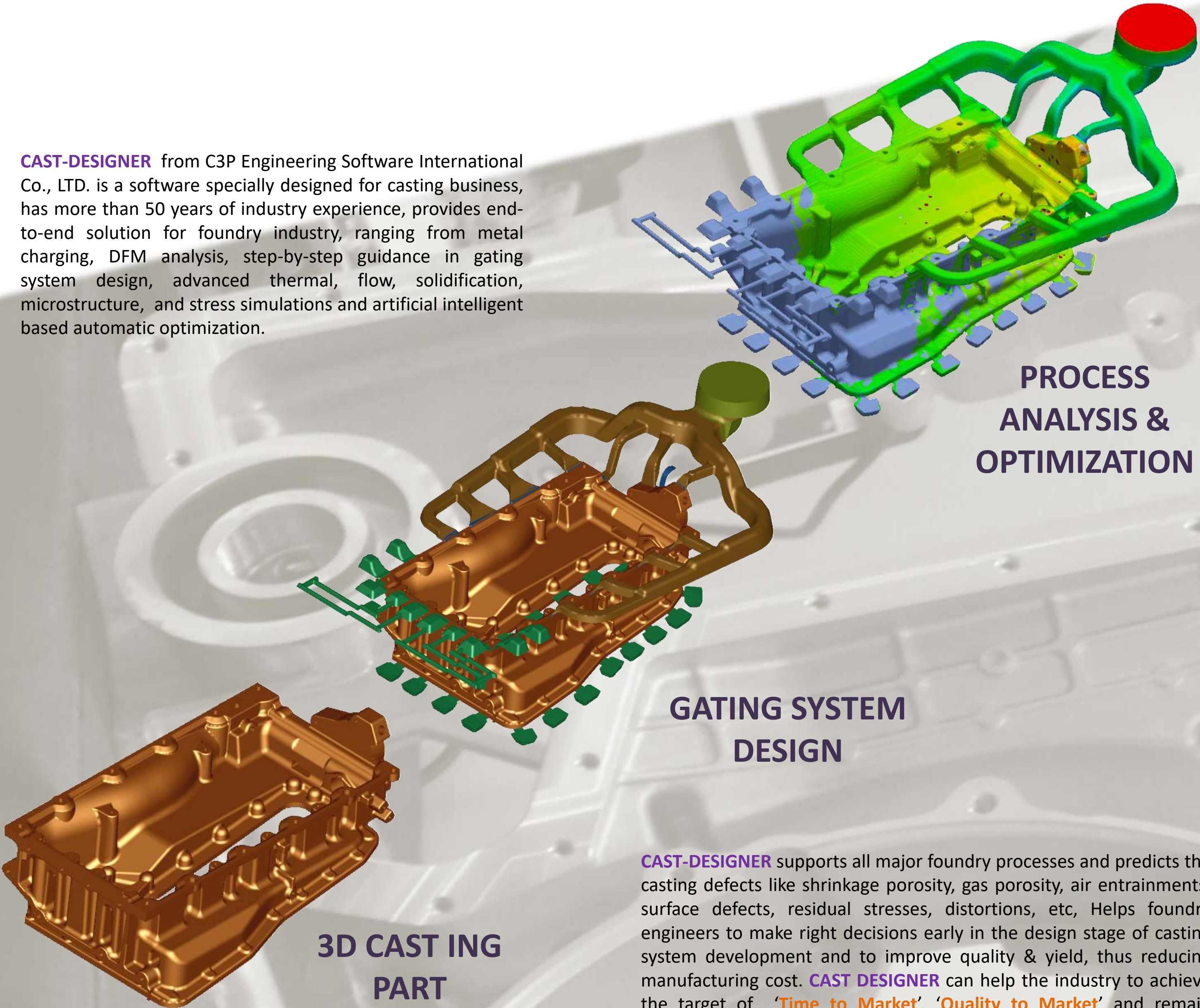
▶ EASY ▶ FAST ▶ ACCURATE ▶ AFFORDABLE

C3P
SOFTWARE

HELPING TO REFINE
THE COMPETITIVENESS OF CASTING INDUSTRY



CAST-DESIGNER from C3P Engineering Software International Co., LTD. is a software specially designed for casting business, has more than 50 years of industry experience, provides end-to-end solution for foundry industry, ranging from metal charging, DFM analysis, step-by-step guidance in gating system design, advanced thermal, flow, solidification, microstructure, and stress simulations and artificial intelligent based automatic optimization.

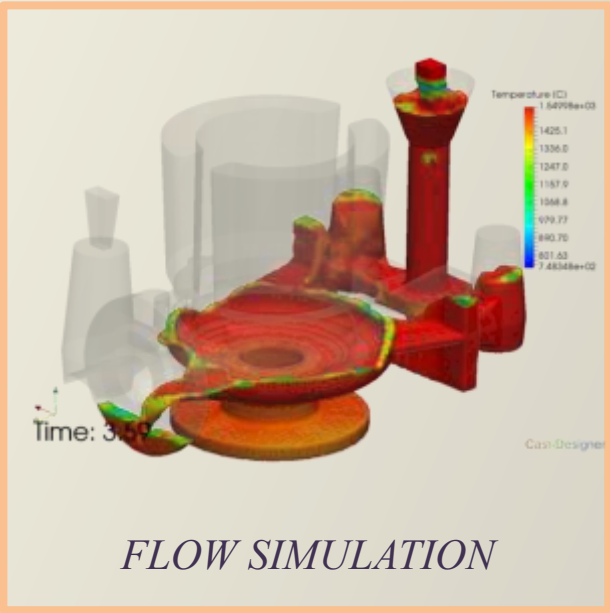
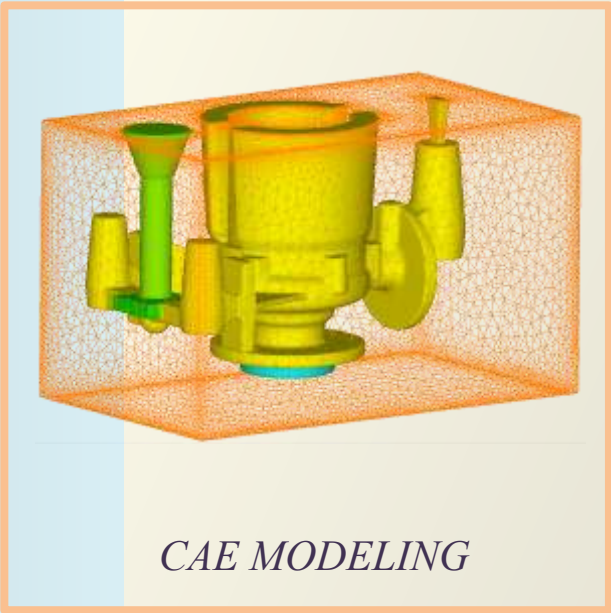
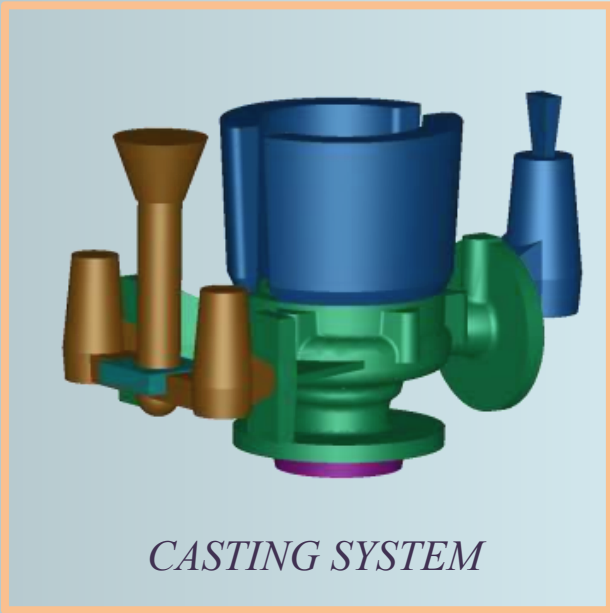
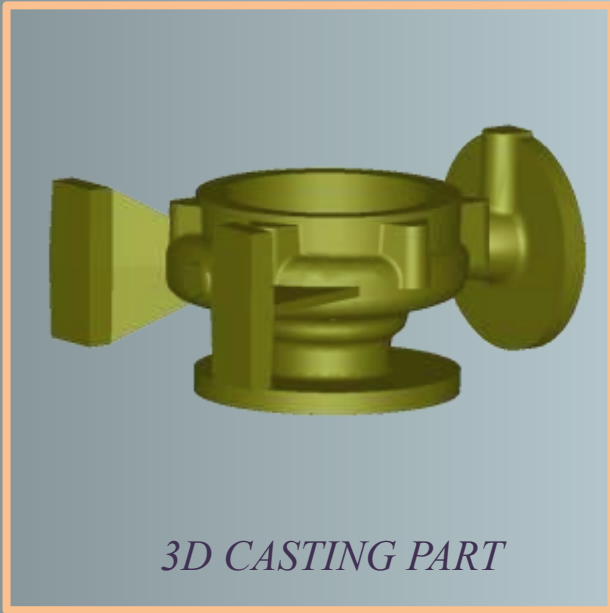


PROCESS ANALYSIS & OPTIMIZATION

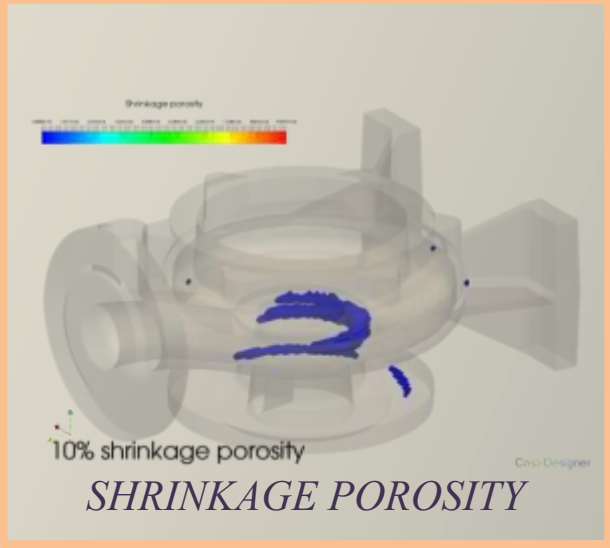
GATING SYSTEM DESIGN

3D CAST ING PART

CAST-DESIGNER supports all major foundry processes and predicts the casting defects like shrinkage porosity, gas porosity, air entrainments, surface defects, residual stresses, distortions, etc, Helps foundry engineers to make right decisions early in the design stage of casting system development and to improve quality & yield, thus reducing manufacturing cost. **CAST DESIGNER** can help the industry to achieve the target of 'Time to Market', 'Quality to Market' and remain 'Competitive'.



CAST-DESIGNER is a quick casting design and analysis tool based on upfront design analysis technology. The core of the “upfront design & analysis technology” is to allow engineers to conduct fluid flow, heat transfer and solidification analysis by the assistance of combination of expert system and CAE technology, it helps engineers to make a “Right” engineering decision in the early design stage of a project. Upfront design & analysis technology has already been becoming a very important role in main stream design process.



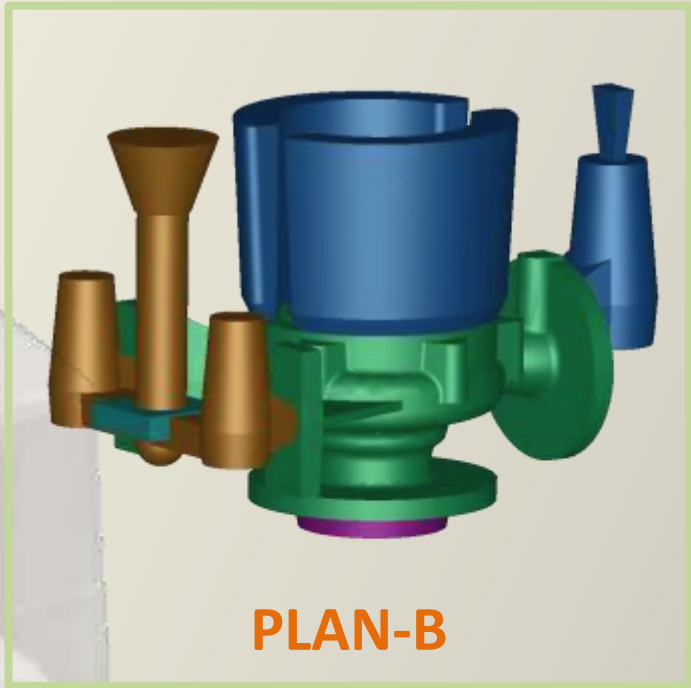
DESIGN PLAN EVALUATION

CAST-DESIGNER provides powerful tools to evaluate difference design plans in fast and easily way.

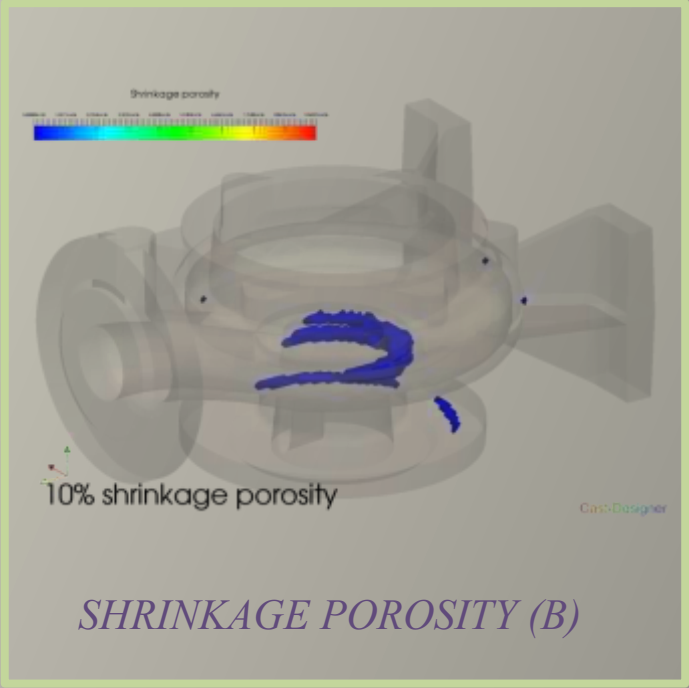
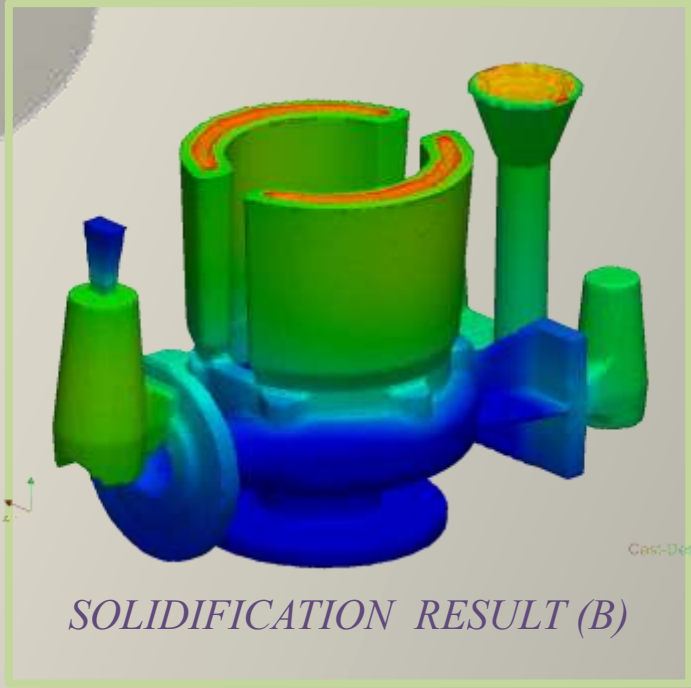
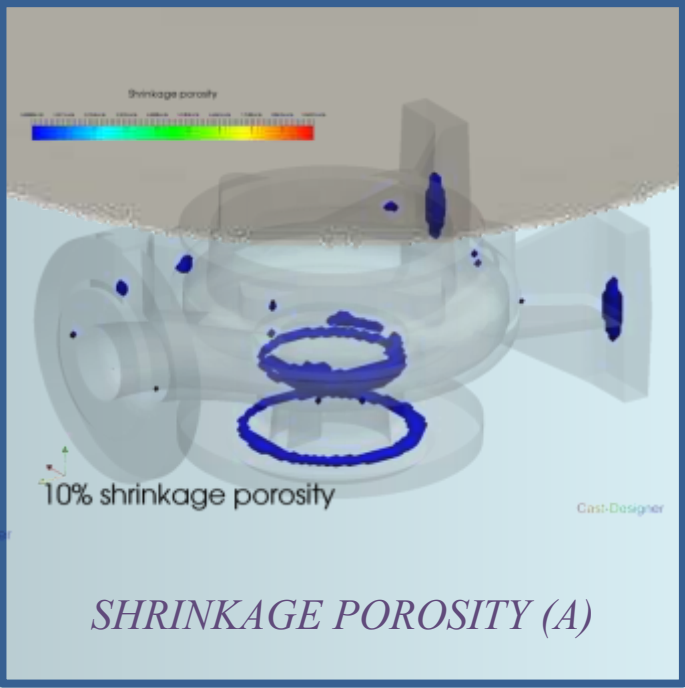
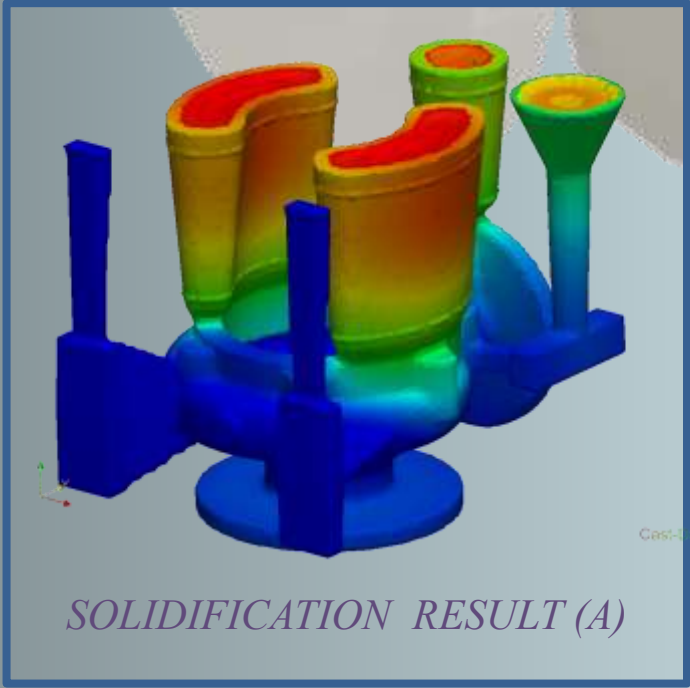
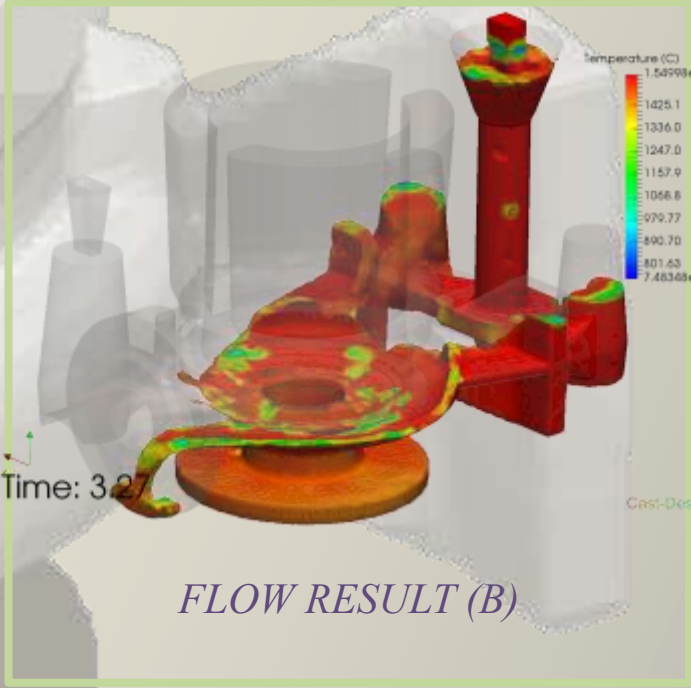
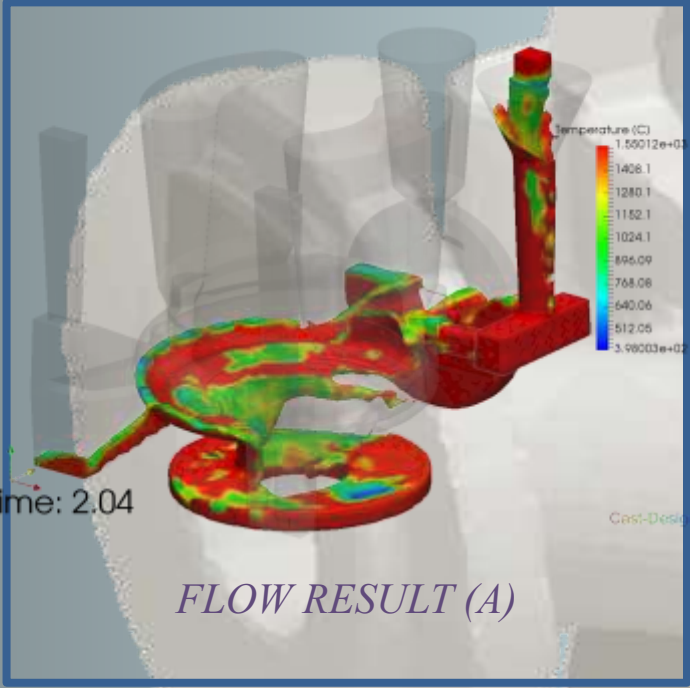
For example, the existed casting part was steel with 23.5Kg, two design plans were studied.

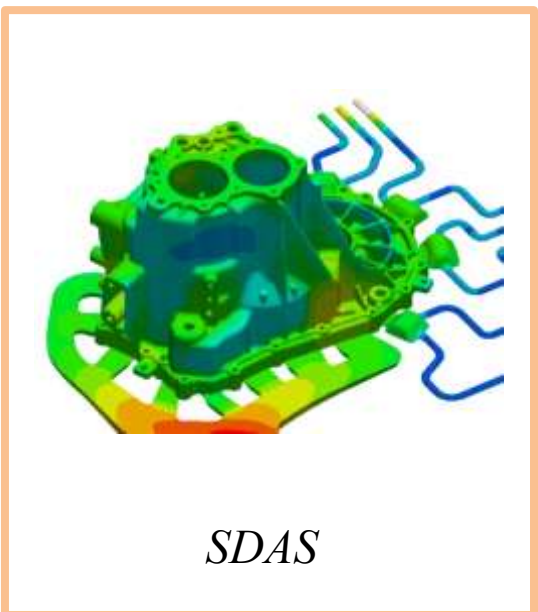
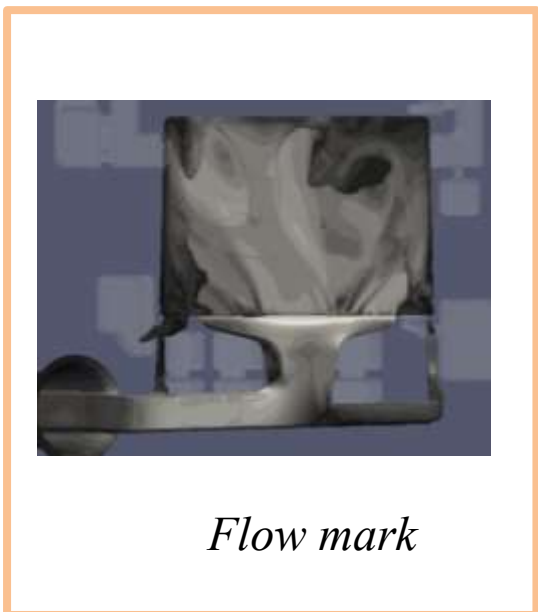
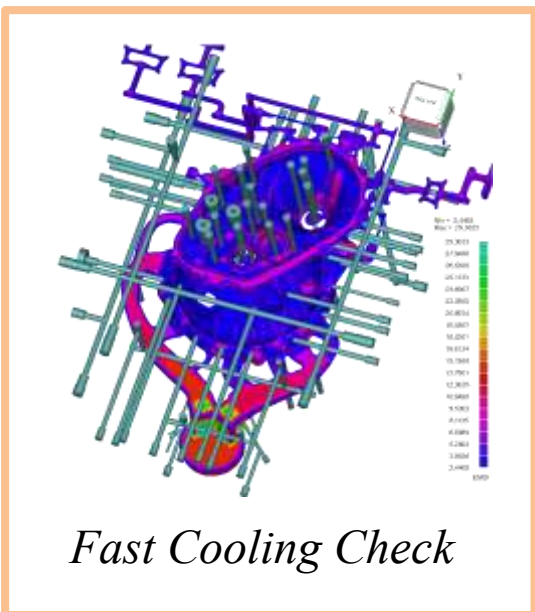
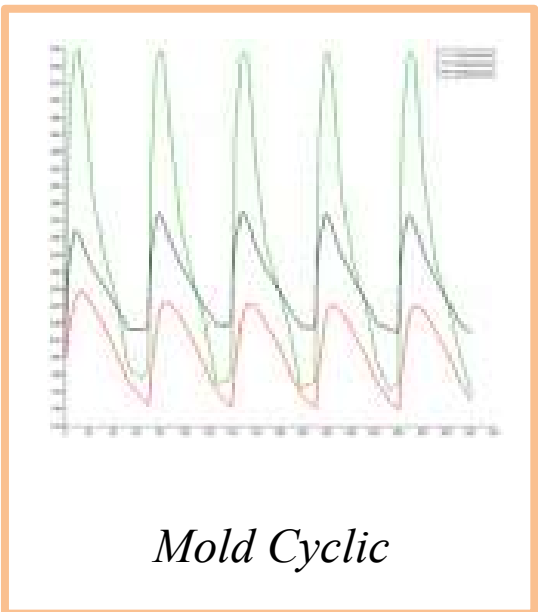
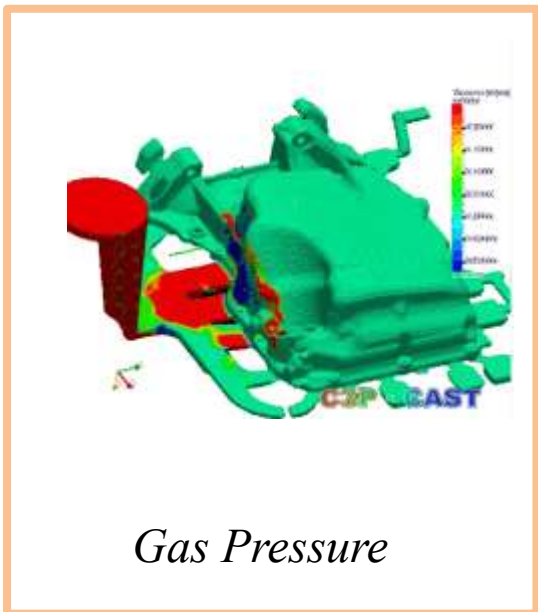
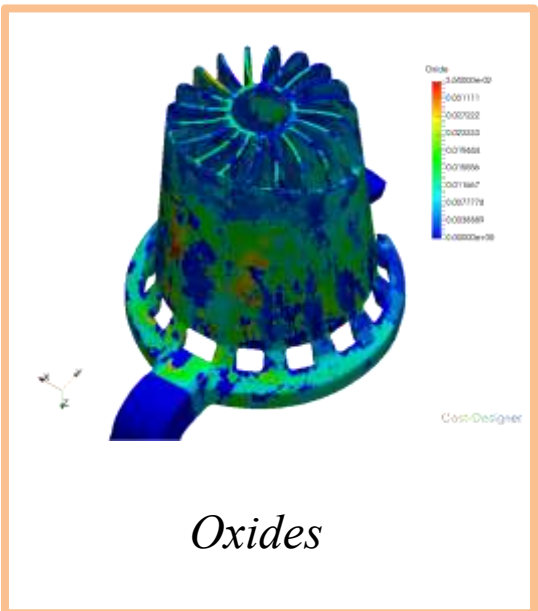
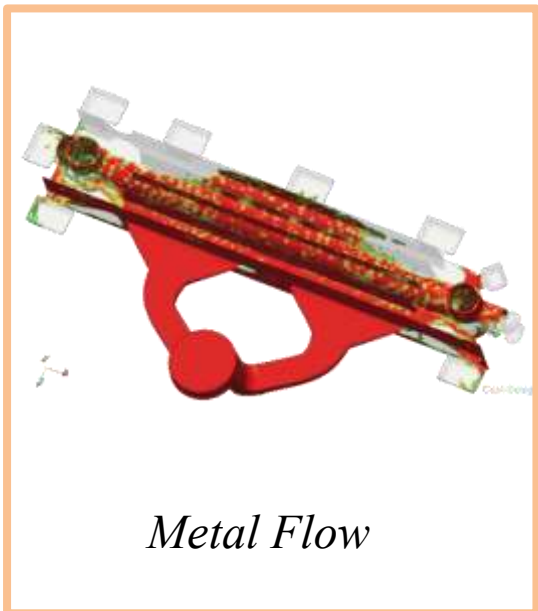
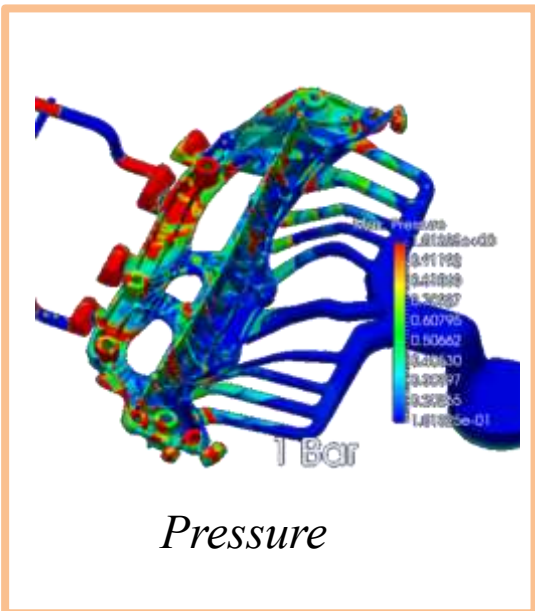
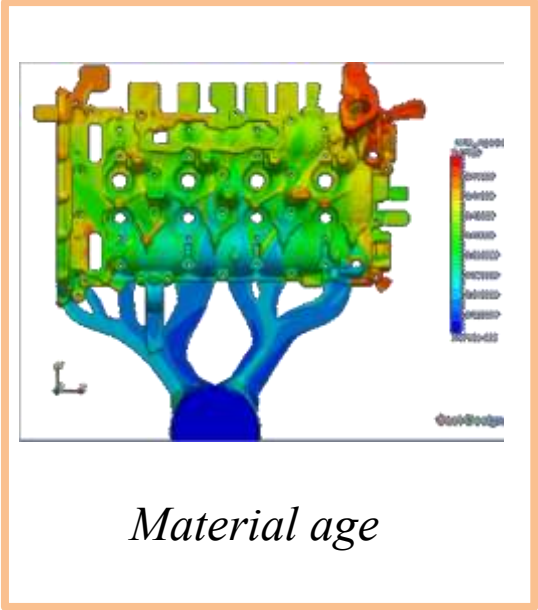
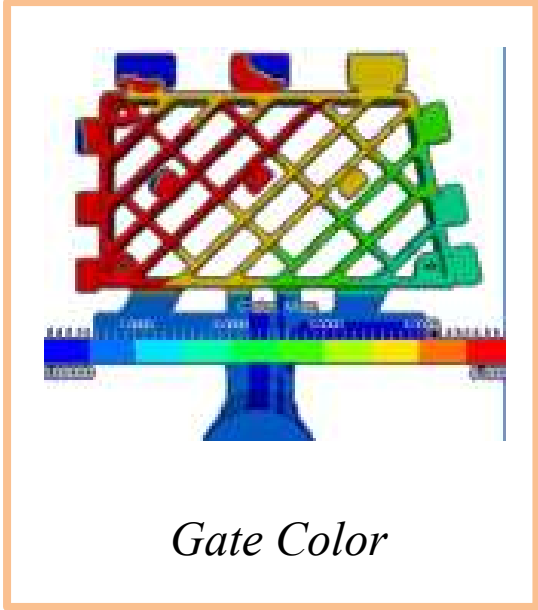
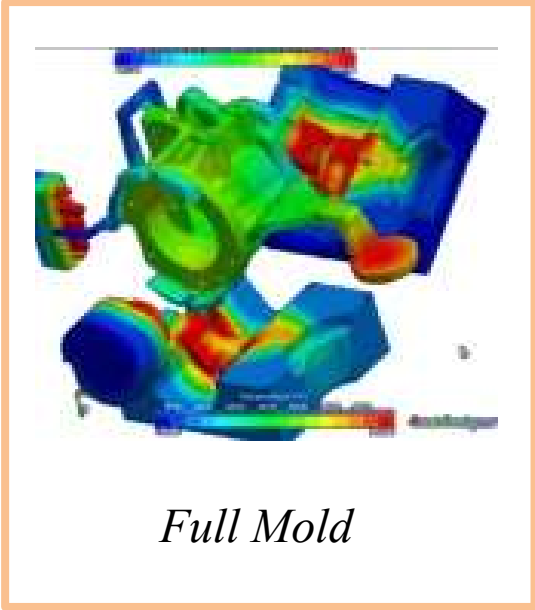
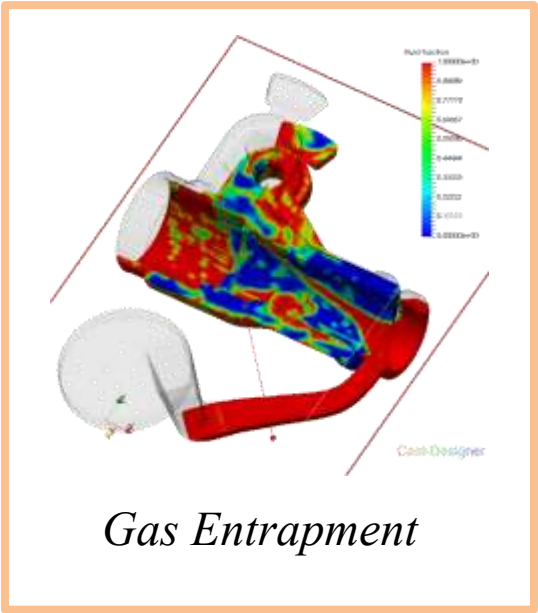
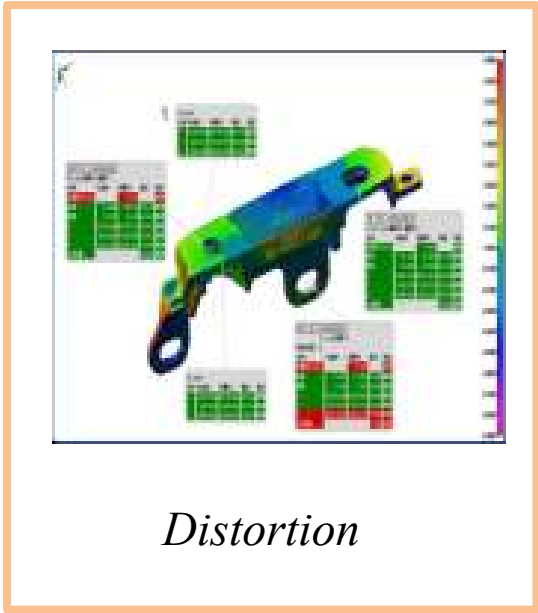
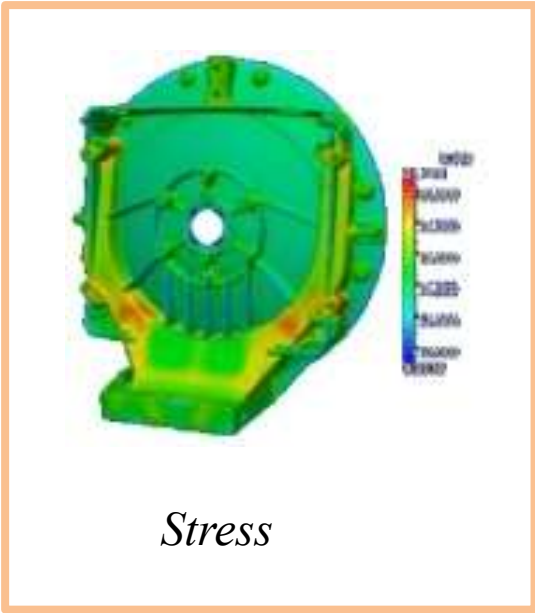
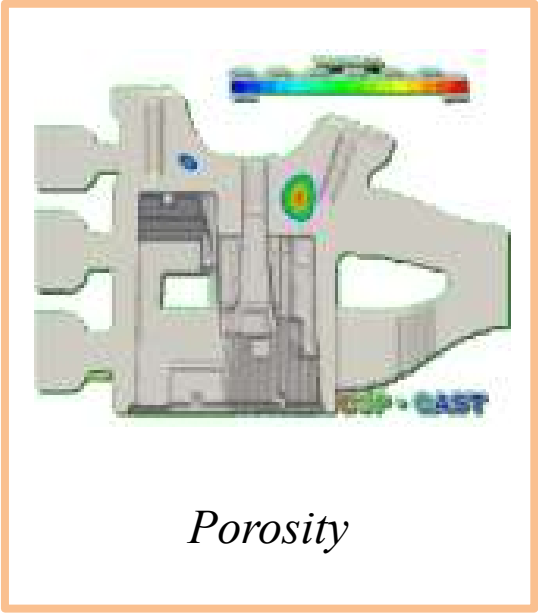
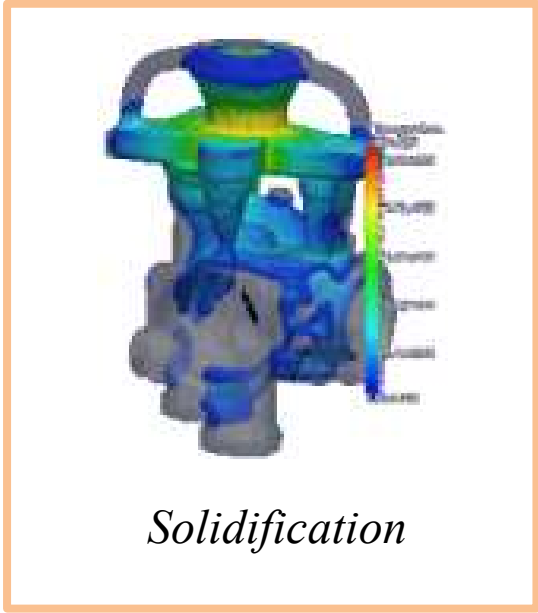
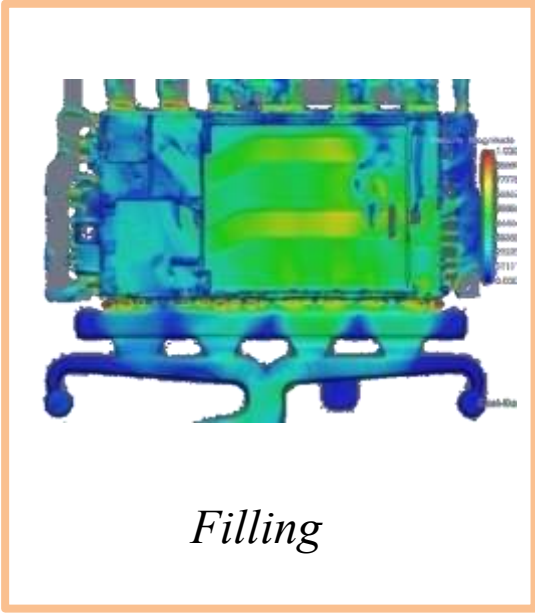
PLAN-A: with 27.2Kg riser and the solidification time was 853 sec, the final shrinkage porosity volume was 20.51 cm³.

PLAN-B: with 26.2Kg riser and the solidification time was 404 sec only, the final shrinkage porosity volume was 4.17 cm³.



With **CAST-DESIGNER**, users can optimize a casting design by detecting the part features with potential flow and solidification problems, evaluating difference casting systems in the early design stage. Even a novel with limited experience in simulation who can easier to undertake the design setup in very short period of time.





FLOW RESULTS

- Flow Fluid Fraction
- Flow Temperature
- Flow Velocity
- Flow Velocity Vector
- Flow Pressure
- Flow Gas Entrapment
- Flow Length
- Flow Material Age
- Flow Oxides
- Flow Vs Gate in colour
- Flow Material Trace lines
- Gas Entrapped Inside Casting
- Gas Entrapped at surface
- Flow Velocity graphs vs Time
- Flow Temperature graphs vs Time
- Maximum Air Pressure
- Filling Time
- Mould Erosion (...)

SOLIDIFICATION RESULTS

- Solid Fraction
- Solidification Temperature
- Casting Temperature
- Mould Temperature
- Thermal Modulus
- Solidification Time
- Shrinkage Porosity
- Niyama Micro Porosity
- Cooling Rate
- SDAS
- Dendrite Arm Spacing
- Ultimate Tensile Strength
- Elongation
- Piping
- Pin Squeeze Analysis
- Temperature graphs (...)

STRESS RESULTS

- Distortion / Displacement
- Compensation for Distortion
- Normal Stress
- Effective Stress
- Strain
- Fatigue
- Hot Tearing (...)

MICRO-STRUCTURE RESULTS

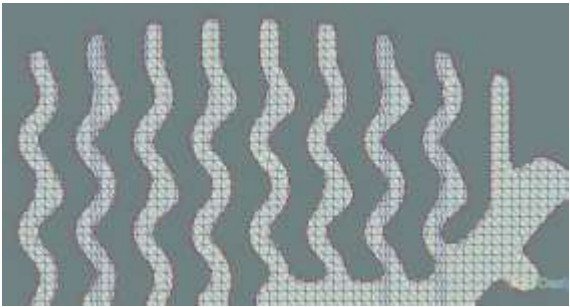
- Phase Contour
- Ferrite etc.
- Hardness
- Grain Radius
- Elongation
- More....
- (Animation & Image)

CAST-DESIGNER CORE TECHNOLOGY

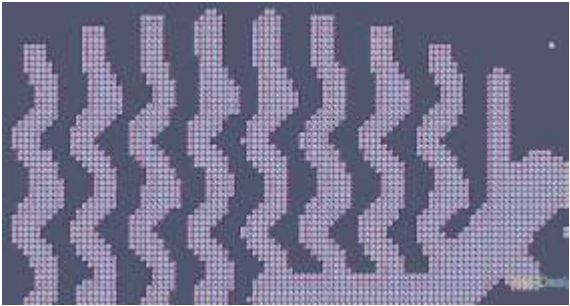
- Dual solver technology, the **FVM solver** and **FEM solver** are fully coupled in the same mesh system.
- Simulate the physical phenomena and mechanical behavior of metal filling, solidification and cooling process. The thermal, flow, stress and micro-structure solvers are fully coupled.
- Stress simulation for both thermal stress and mechanical stress.
- Innovation technology to speed up simulation in express, less than three hours for almost cases.
- Build in CAD kernel, fully parametric gating system design with KBE system.
- Excellent parallel computing performance.
- Full CAD driven automatic optimization solver, all geometry and process parameters are possible optimized.
- Special quick mould simulation technology to speed-up the modeling time, but take account the affection of cooling system and physical cores with high accuracy..

UNIQUE MESH TECHNOLOGY

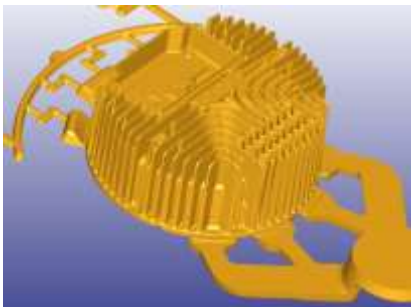
- Very strong 3D hexahedron and tetrahedron mesh capability, fully automatically
- Support GUI mode and batch mesh mode, fully parametric, easy to remesh.
- Special treatment for CAD defects, i.e. geometry gap, overlay, intersection or unclose, face lose etc.
- Rich mesh options: local mesh, mark point, tin region mesh, 2D surface mesh, shell mesh, advance mesh smoothing, quality control etc.
- Fully automatic mould assembly with node connection, support mixture mesh type.
- Parallel meshing capability, suitable for the Giga casting part and complex mould assembly.



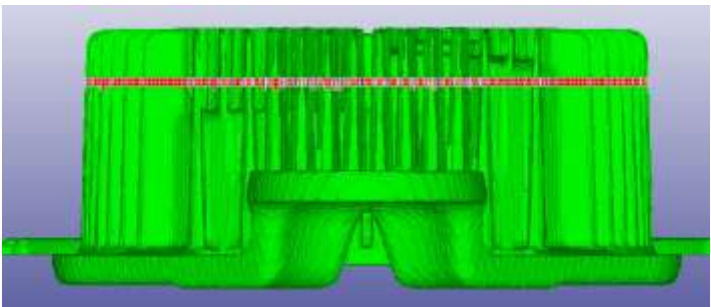
Section of Cast-Designer mesh



Section of tradition FDM mesh
Geometry was not accurate
(Red line: CAD profile)



CAD Geometry



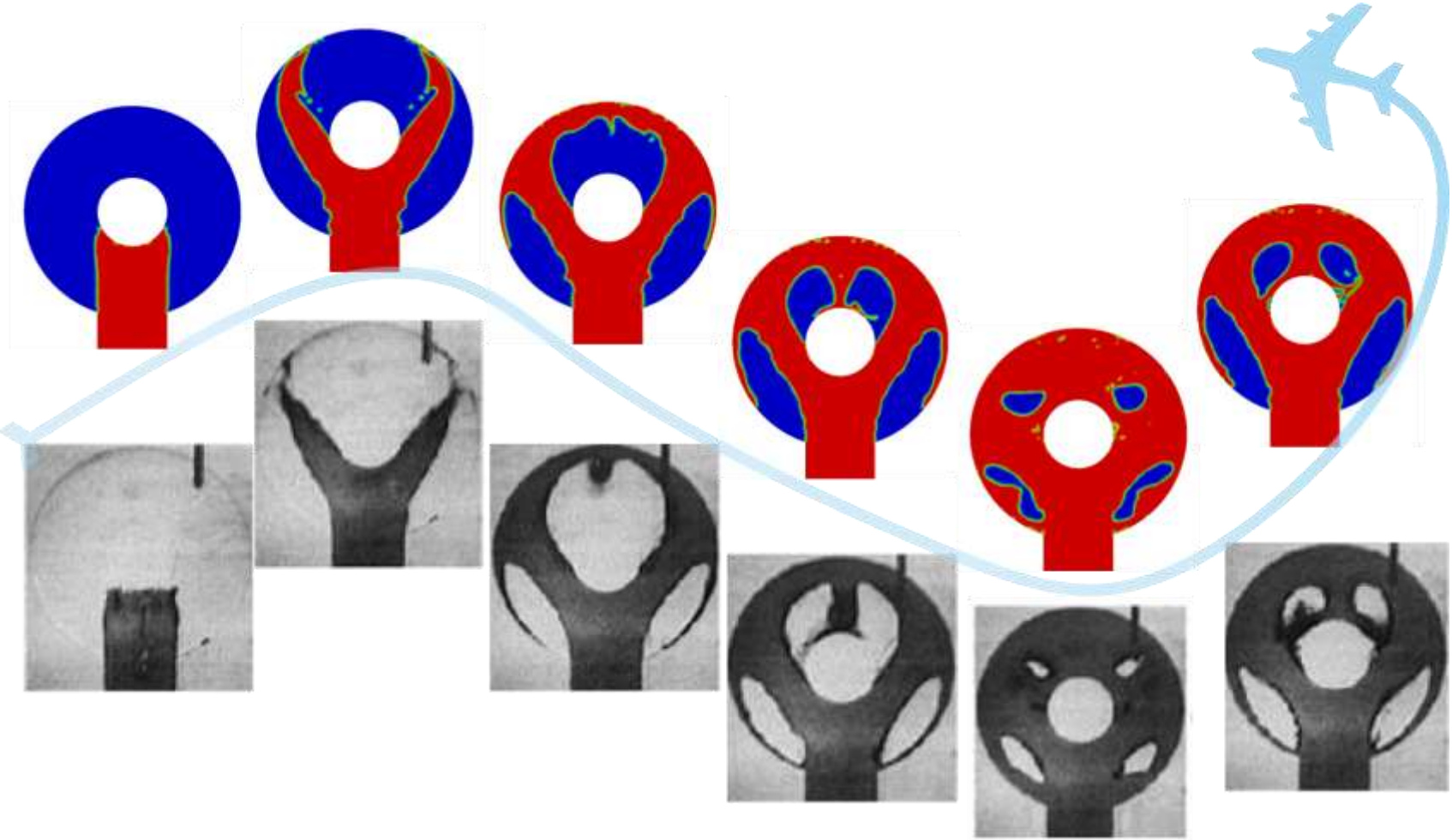
Cast-Designer Fastmesh result
(in 301,516 elements)



Tradition FDM mesh
(in 1,298,853 cells)

ADVANCED CFD SOLVER

CAST-DESIGNER's powerful Computational Fluid Dynamics (CFD), FVM based solver, incorporates many advanced features in flow the calculation like surface tension effects, viscous shear stress combined with gravity leads to buoyant flow, turbulent phenomena greatly enhance the diffusion of momentum and enthalpy also modelled. For fluid dynamics simulation, the algorithm solves equations of conservation of mass and momentum for any number of immiscible, incompressible fluids, and tracks the interfaces between them, two fluid model (liquid metal + air) effective in bubble formation.



Simulation result of Cast-Designer CFD Solver (up) vs experiment (down). The experiment was performed by Dr. Markus Schmid at ARGE Metallguss in Aalen, Germany

DESIGN FOR MANUFACTURING

Upfront quick casting part analysis tool to find Hot-Spots, Mass distribution, Wall Thickness, Slider zone, Ejection force calculation and Core model extraction as well as Part optimization.

GATING DESIGN

- Gating Design Tools and Advisors for HPDC, LPDC, Gravity and Investment Casting Processes etc.
- CAD modeling capability
- Export to 3D CAD system directly

CASTING PROCESSES

- Gravity Casting
 - Sand / Permanent / Tilt Pouring
 - Investment / Shell Casting
 - Lost-Foam Casting
- High & Low Pressure Die Casting
- Semi-Solid Casting
- Continuous Casting
- Centrifugal Casting
- Core Blowing

SPECIAL PROCESSES

- Mechanical & Thermal Stress
- Micro-Structure Analysis

AUTOMATION & OPTIMIZATION

- Casting Part Optimization
- Gating Optimization
- Process Optimization
- Design of Experiments
- Production Optimization
- Distortion Compensation

RAW MAYERIAL OPTIMIZATION

SavingCAST, can provide optimized mix of raw materials, scrap, or return materials at lower cost for the specified alloy mix.

MATERIAL DATABASE

CAST DESIGNER has more than 400 industry standard materials in the database including Cast iron, Steel, Stainless Steel, Copper, Mg, Zn, Ni, Lead, Gold, Silver & Aluminum alloys and varieties of mould, sand, filter & sleeve materials



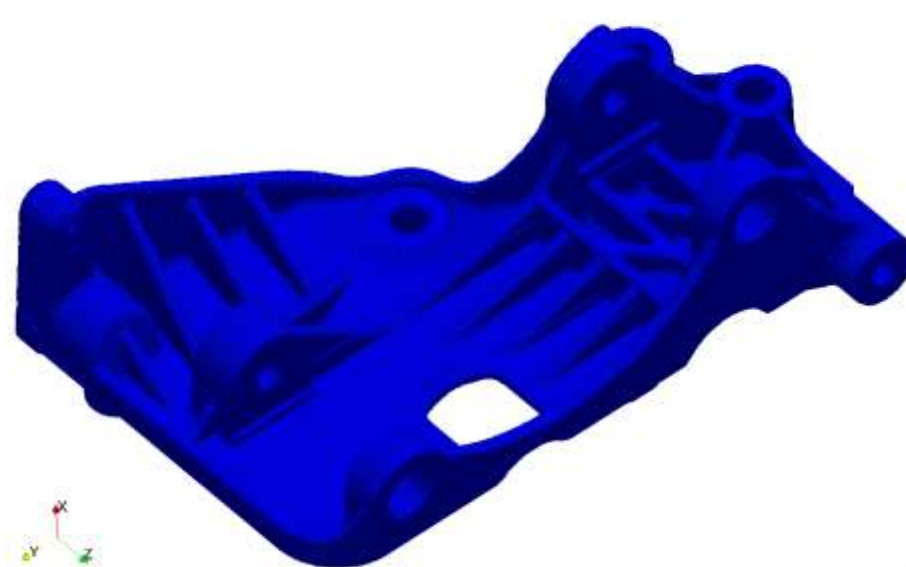
Geo-Designer is a powerful upfront Design For Manufacturing (DFM) tool for designers and manufacturing engineers with innovative technology. DFM Analysis is the FIRST STEP for part manufacturing. It is the bridge to link the part designer and manufacturing suppliers.

Find critical points in casting manufacturability and respond to RFQ quickly

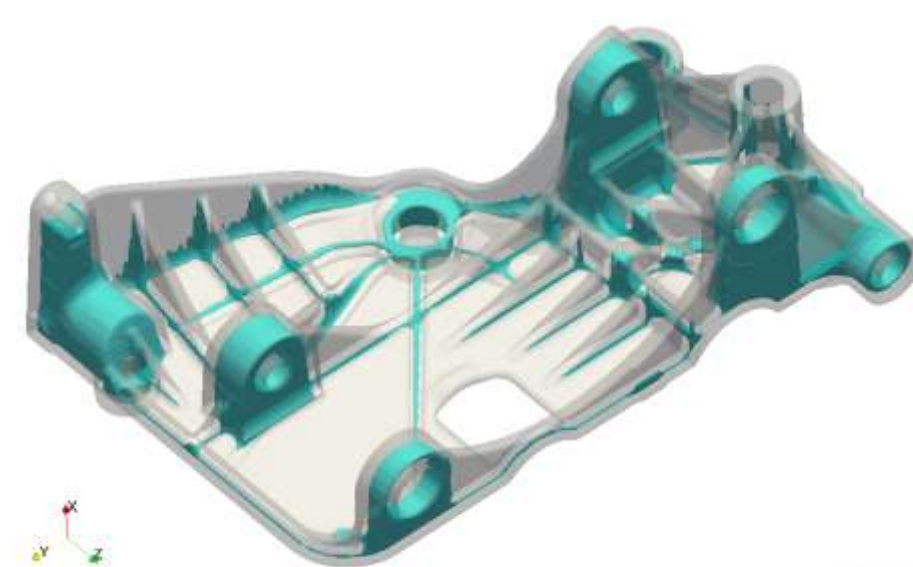
FIND HOT SPOTS! IN 3 CLICKS, 3 MINUTES



Insert CAD



Create DFM model



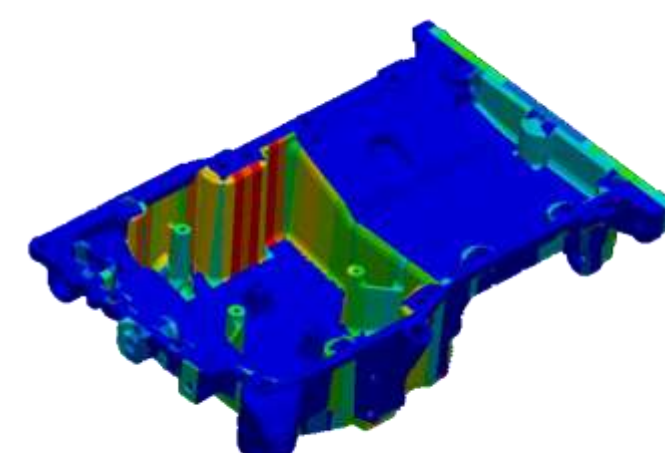
Find Hot Spots in minutes

GEO-DESIGNER FEATURES

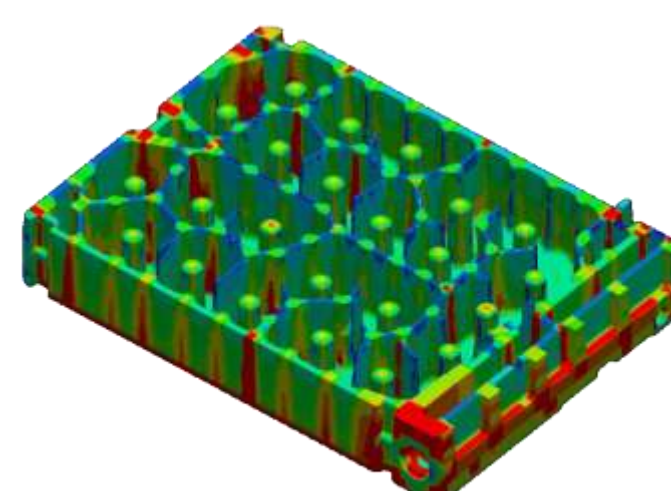
- Standalone software, also integrate into **CAST-DESIGNER** systems
- Build in last CAE technology for geometric front analysis
- Express mesh technology for STEP/IGES file object.
- Checks wall thickness, **Mass Distribution Index(MDI)**, **Heat Distribution Index (HDI)** on complete model
- Build in design capability
- Support 3D ISO-surface and multi-sections mode
- Ease in locating critical thickness areas
- Advanced visualization for easy interpretation of results
- Ability to clip model at any section
- Dynamic information display at point click
- Powerful filter mechanism to concentrate on region of Interest. Detail information of analysis model: mass, volume, surface area, project area, heat modulus etc.
- Support contour, section, Iso-surface and curve, Import STL, IGES, STEP file directly
- Design result could be exported to 3D CAD system directly
- Flexible report generation, VRML output
- Support language: English, Japanese, Chinese etc.



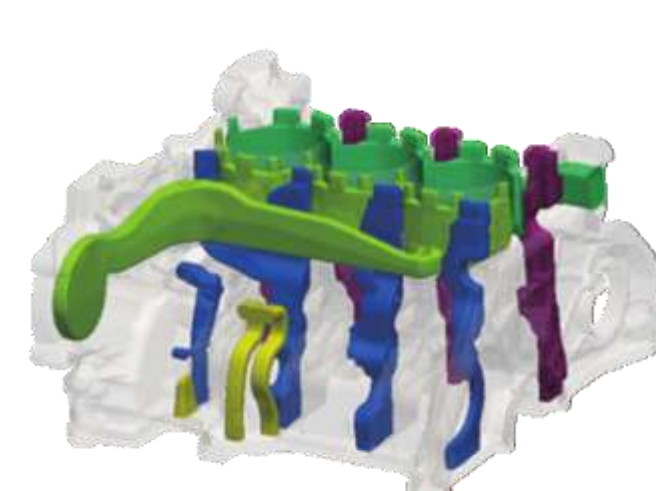
Detect Slider Zones



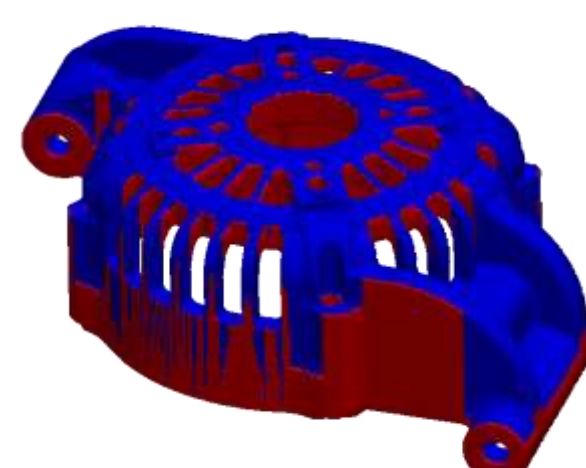
Find Ejection Force



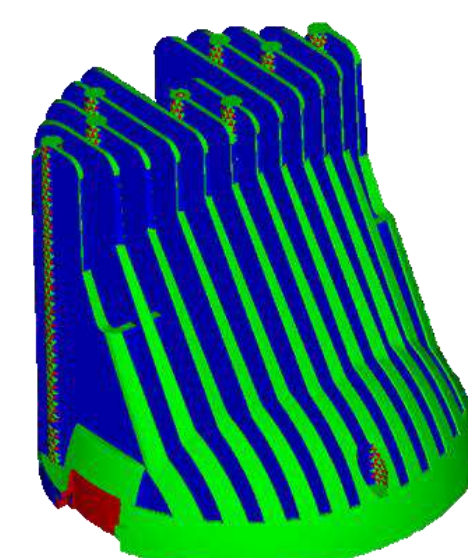
Thickness Analysis



Extract Core Shape



Find Parting Line

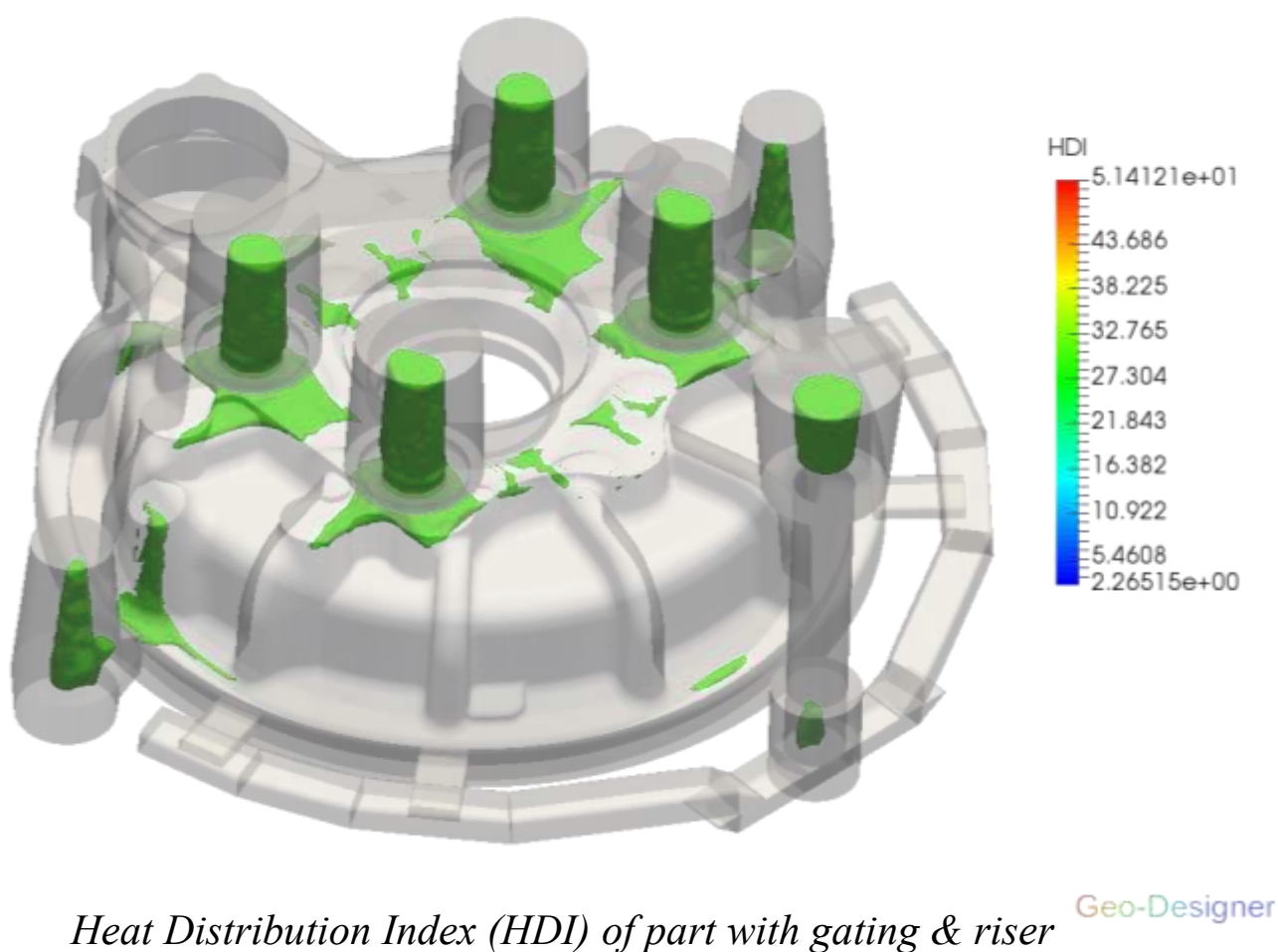
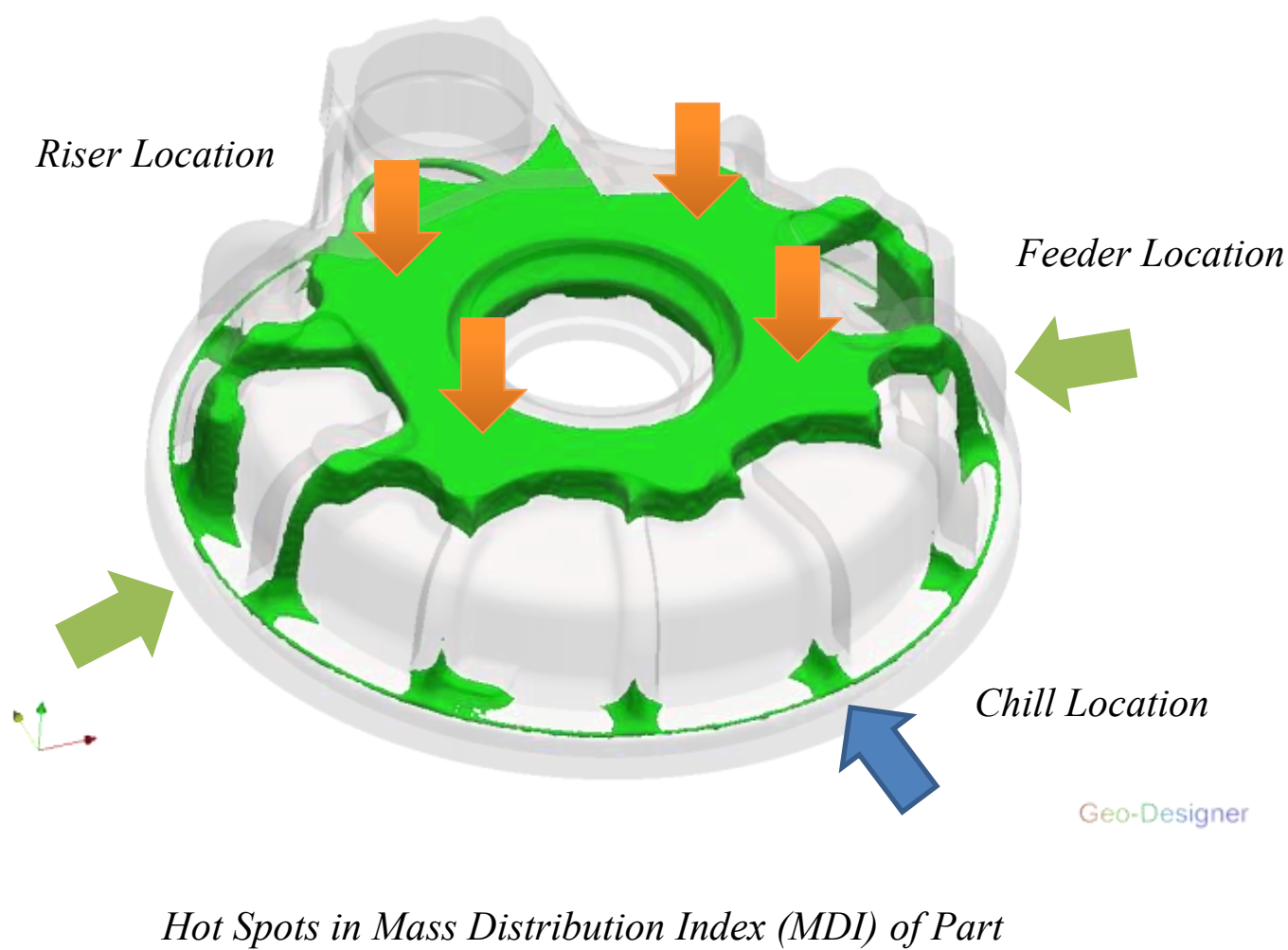
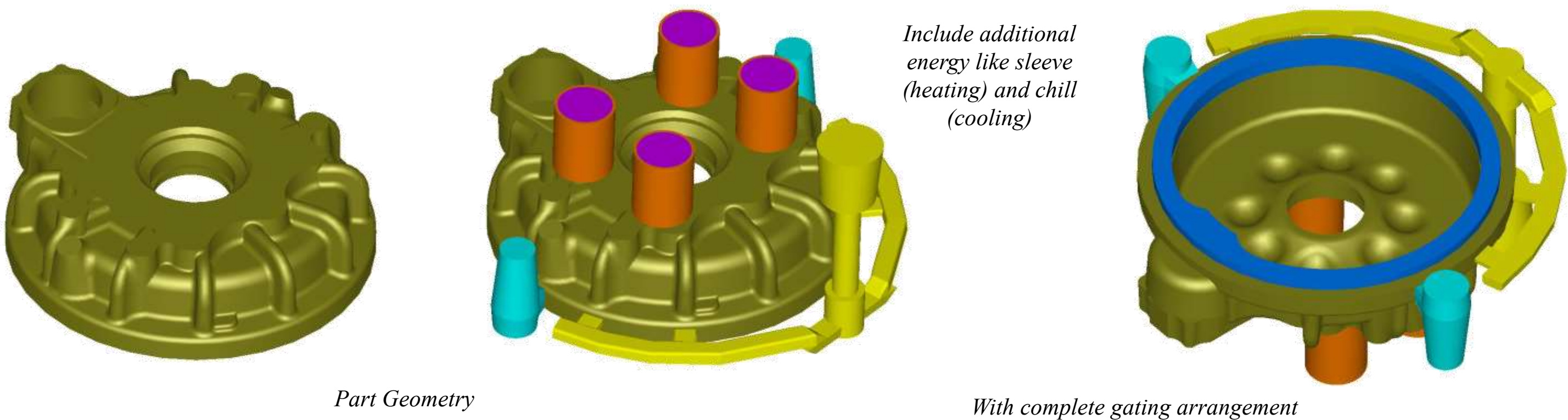


Draft Analysis

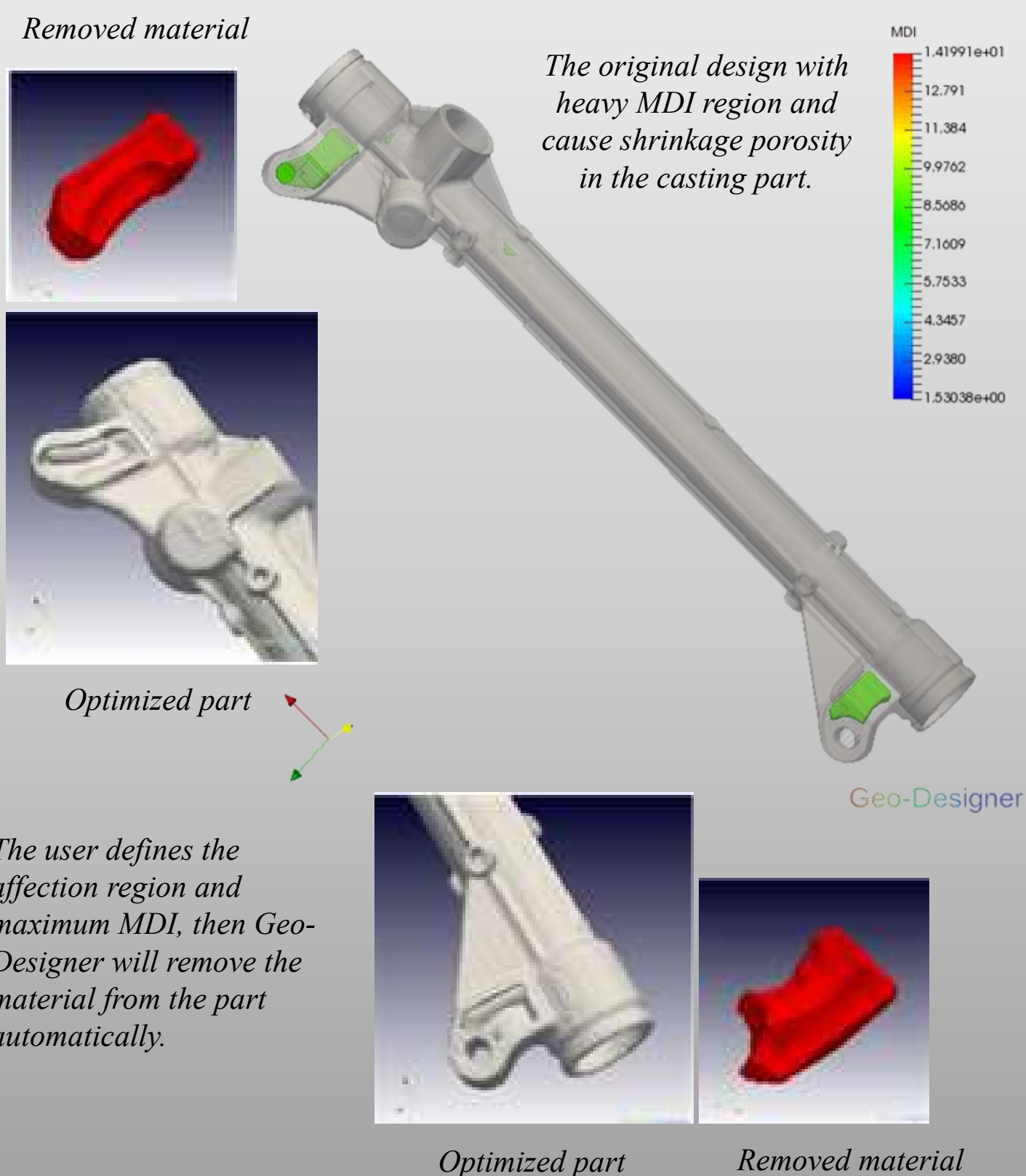
Heat Distribution Index (HDI) also considers heat affection of the additional heat energy sources, which helps user to effectively design gating design with risers, chills and sleeve on the hotspots and make design decisions quickly.

Geo-designer Can Predict 90% Of Shrinkage Porosity Problems In 3 Minutes

EXAMPLE: RISER,FEEDER DESIGN FOR SAND CASTING



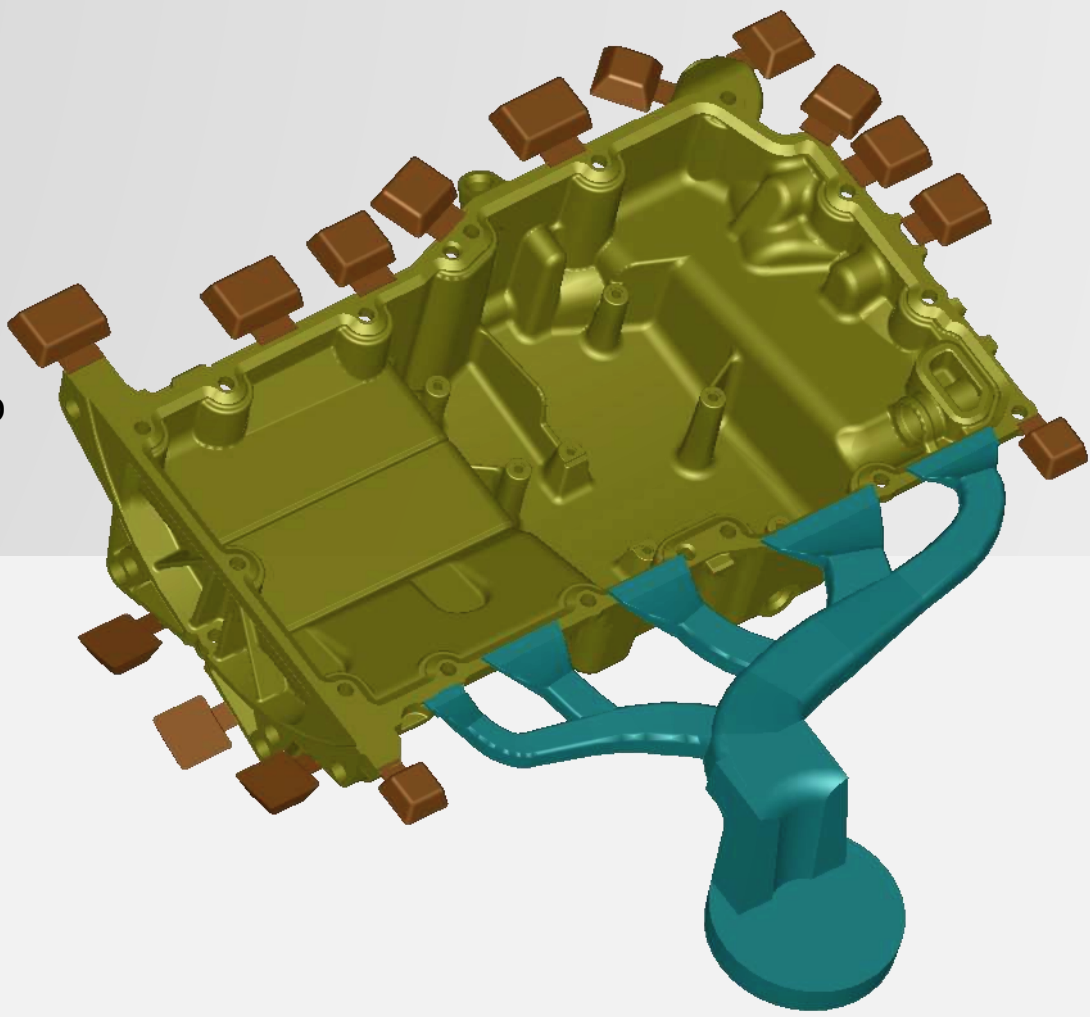
PART OPTIMIZATION



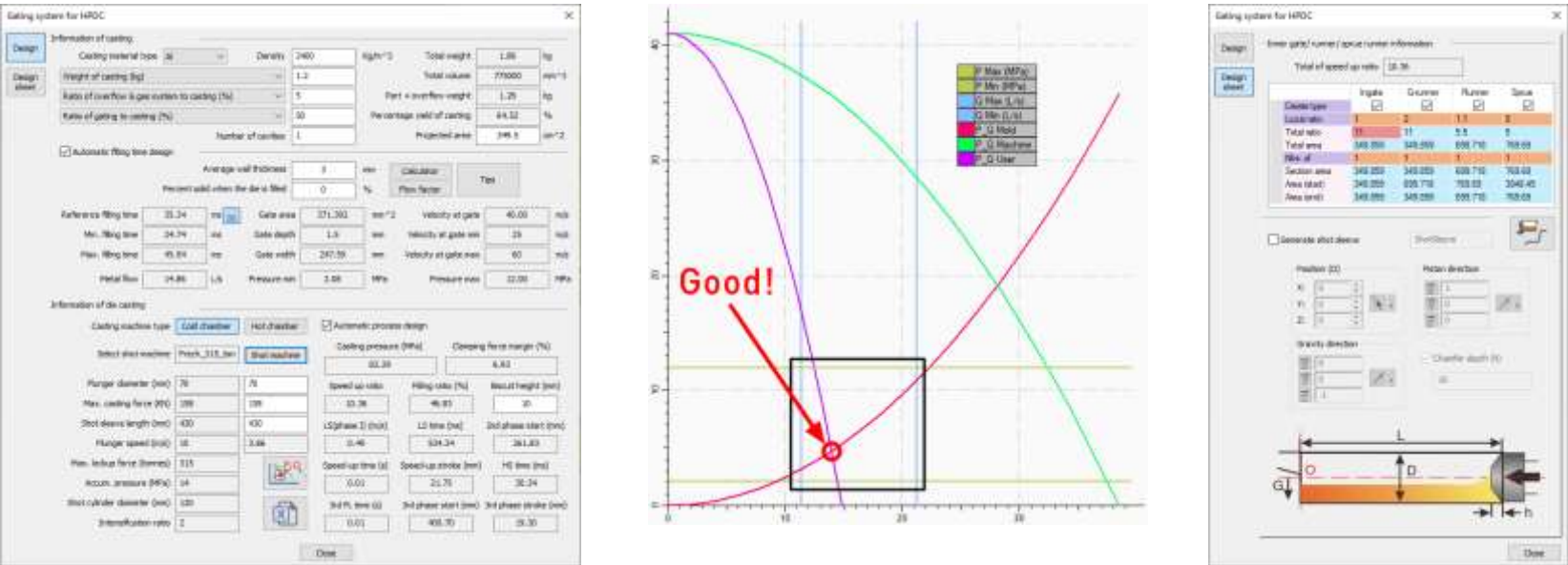
The 'Part Optimization' function can automatically remove material from the casting part to achieve a given maximum HDI/MDI value to avoid hot spots in Casting process. The removed geometry could be exported to CAD system in STL file format.

CAST DESIGNER’S Gating Design Advisor is designed with 50 years of industrial experience and NADCA standard recommendations. It provides step-by-step guidance to the user to design an effective gating system, starting from the shot machine selection, inner gate area, runner section, velocity, fill-time, over flow, venting and cooling channels etc.

With **CAST-DESIGNER’S** Automatic Optimizer, this initial gating design could be fully optimized to produce error-free castings.



DESIGN TOOLS FOR HPDC

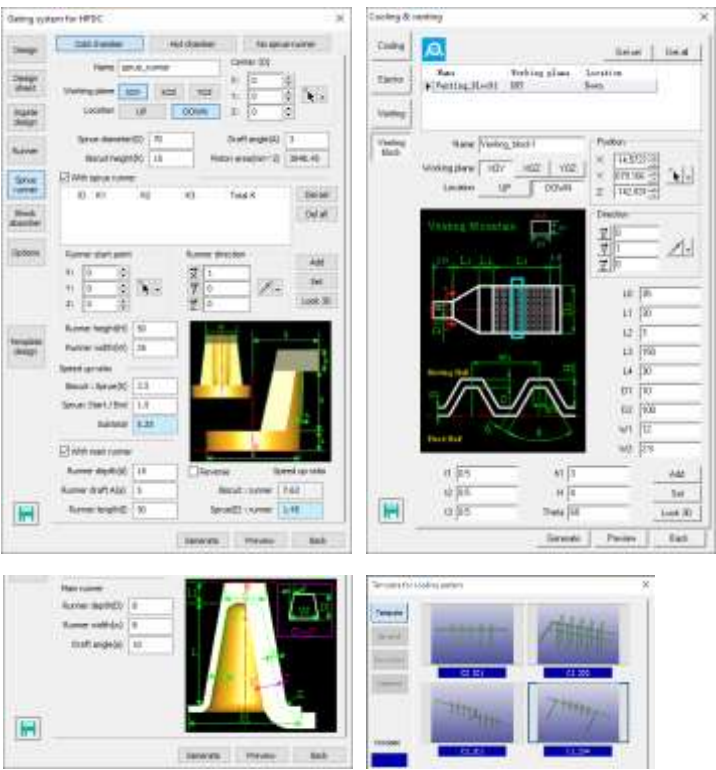


PQ Graph Evaluation of the gating system design

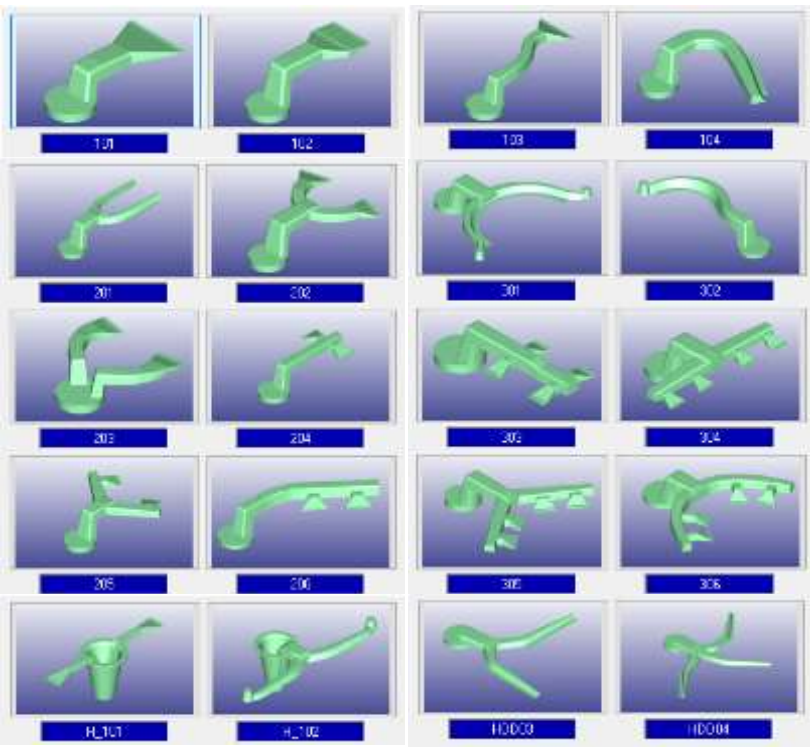
Gating Design Advisor main page

Shot sleeve and vacuum design

- PQ Graph evaluation of the design
- Provides fill time and required inner gate area
- First phase and Second phase velocity



Detail components design



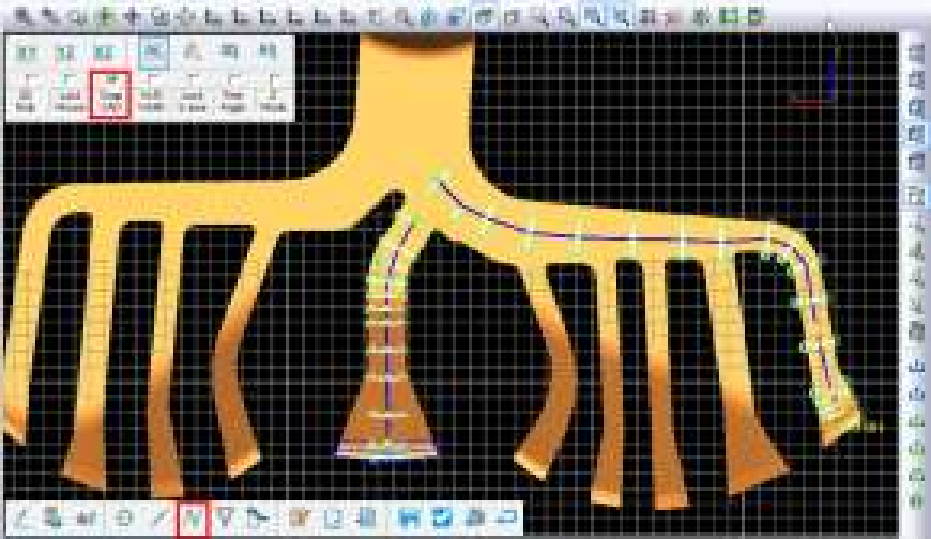
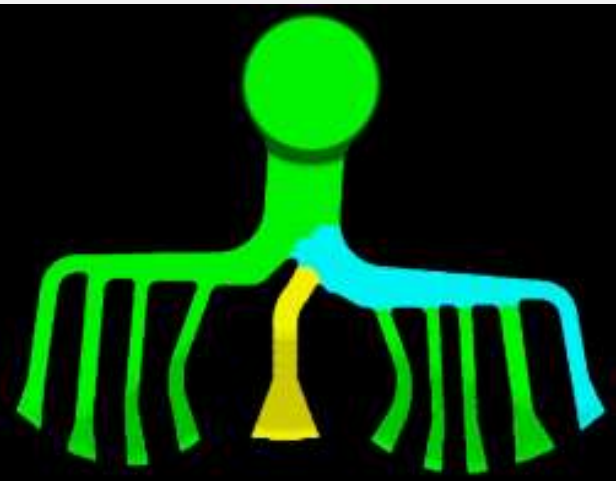
Parametrically defined “Template Gating Designs”

- Cooling channel calculator
- Overflow requirement calculator
- Sprue runner, venting design tools

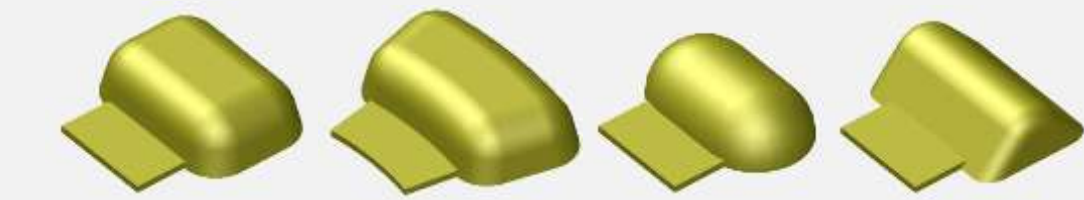
- **Shot Machine Tonnage Calculation Tool:** Using user given projected-area of the casting and casting pressure category, this tool provides shot machine tonnage required to manufacture the casting.
- Shot Machine Database:** **CAST-DESIGNER** has collection of shot machine data. This database can be referred for machine tonnage and for PQ graph analysis.
- Casting Wall Thickness Analysis Tool:** A handy tool to find average wall thickness of the casting and thin and thick regions in the casting.
- **Casting Zone Analysis:** The QuickCAST function can help the size and location of inner gate design to define casting zone and have an uniform filling.
- **Auto Runner:** Help create smooth runner of gating system automatically.
- **Runner Combine:** Combine several runner together, all the section area and feature sections will be adjusted automatically.

REVERSE ENGINEERING OF EXISTING GATING DESIGN

- Special tool for **Reverse Engineering** of existed gating system from ANY CAD system(CAD, STL, mesh etc.)
- Convert to full parametric gating in few minutes to optimize the design performance.
- **3D runner projection** is another useful function to convert the 2D plan runner to complex 3D runner.



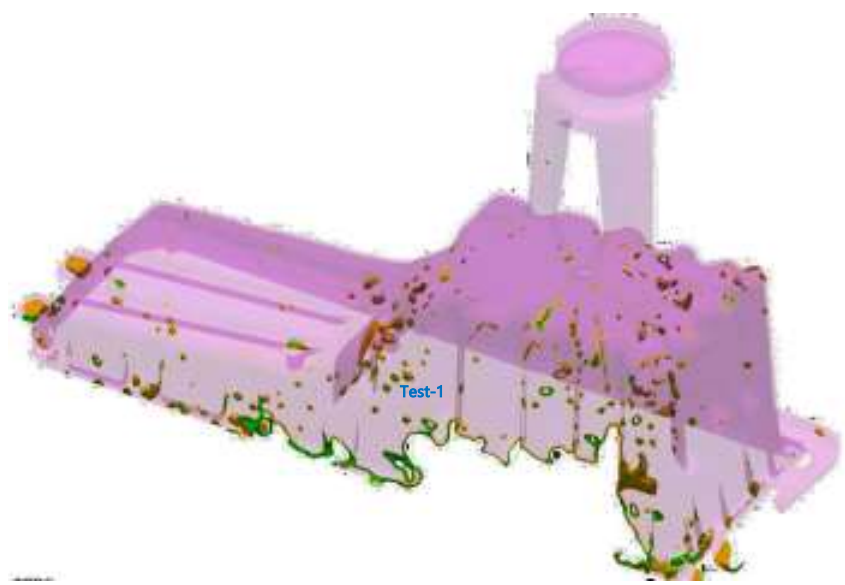
With parametrically designed gating model, it is easy to modify the design for better flow performance results



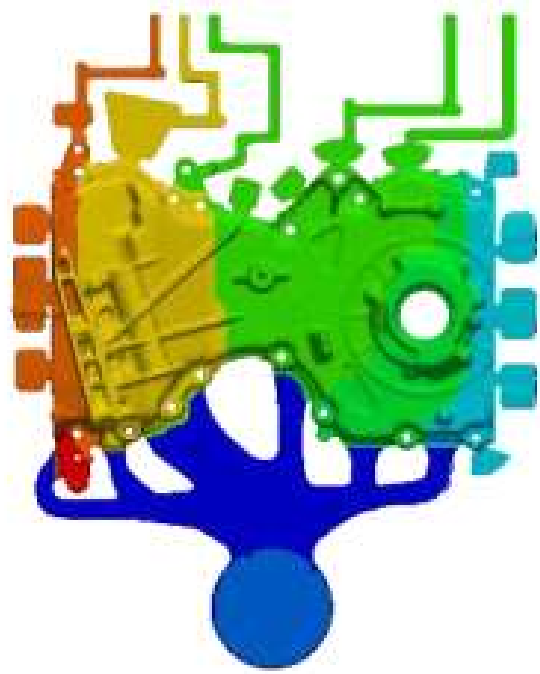
- **Shot Sleeve Model Generator and Velocity Curve Generator:** CAD models are automatically created with filled, unfilled regions and piston of the shot sleeve. Piston velocity or distance curve can be created and verified for vacuum system and shot-machine’s capability.
- **Overflow Design Tools :** Different standard shapes supported. The size of overflow could be adjusted by one global parameter.
- **Cooling Calculators and Design Tools :** Cooling channels calculator helps designer to arrive at length and diameter of the cooling channels and design tools to create cooling channels for analysis.
- **Venting Calculators and Design Tools :** Chill vent designer can create standard design quickly.

FLOW TURBULANCE, AIR ENTRAPMENT, BUBBLE MOVEMENT & TEMPERATURE

CAST-DESIGNER'S CFD solver considers surface tension effects, "slushy" flows and turbulent currents, including wall pull-away, splash effects. Two-fluid calculates air bubble formation and its movements are tracked well. These defects can be precisely analyzed which helps designers optimize their gating system and better position the vents & overflows.



GATE COLOUR / METAL TRACING



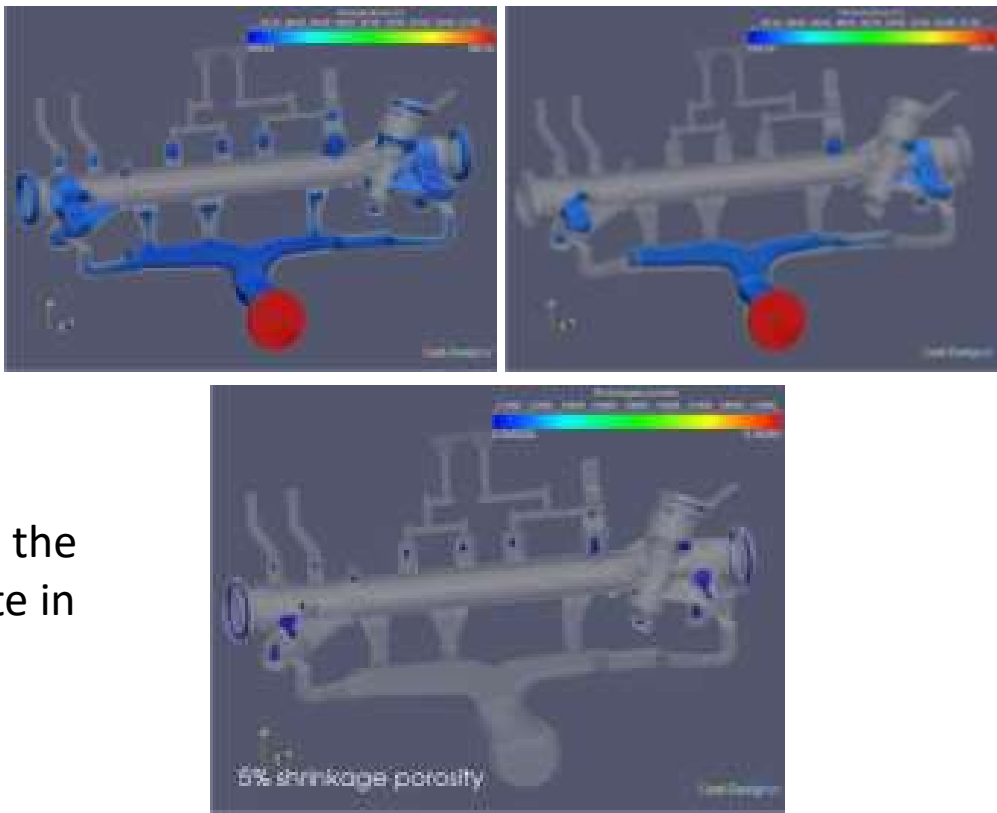
OXIDES, MATERIAL AGE, COLOURED FLOW PATH

Flowing metal is tracked throughout the filling process and provides vital information such as material age, flow length and gate wise coloured flow path to help design balance the running system, in the case of multiple inner gates.

CAST-DESIGNER accurately tracks oxides formation during flow and their final locations.

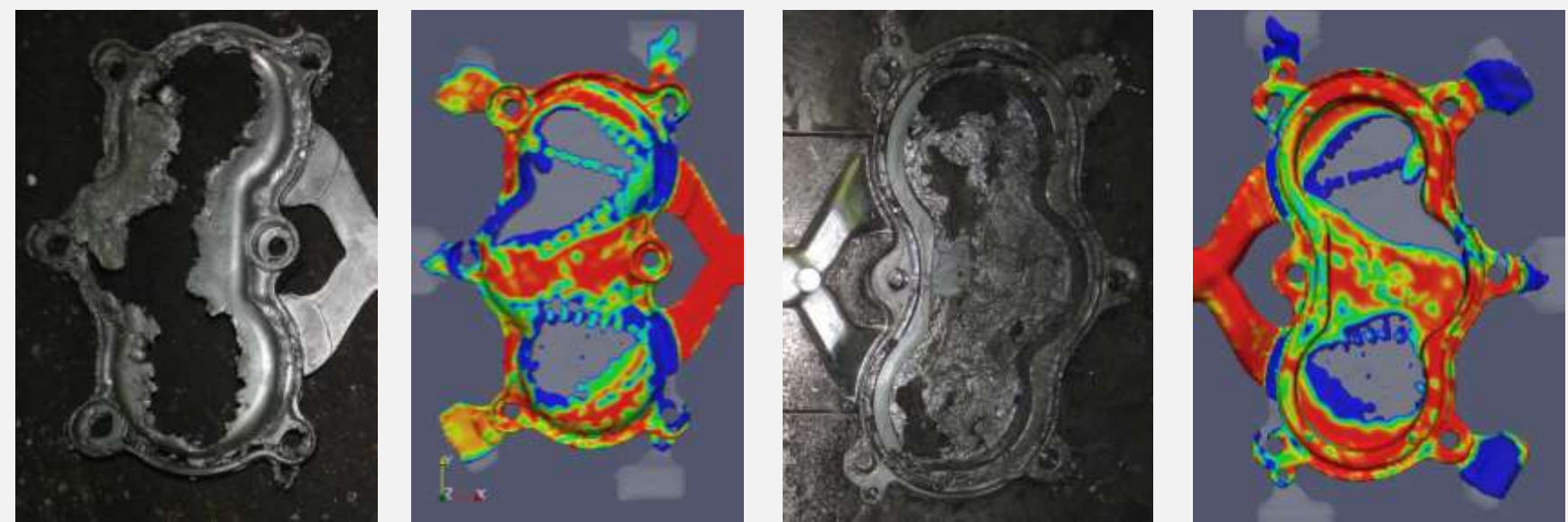
SOLIDIFICATION & SHRINKAGE POROSITY

Accurately predicts the shrinkage porosity, taking into account of the expansion of cast alloy and the density variations that occur during the cooling process in the solidification.

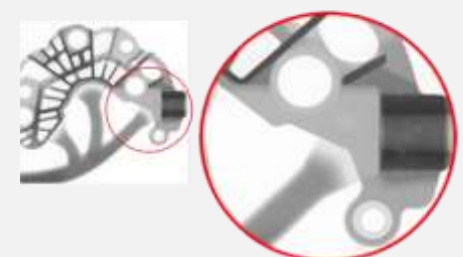


CAST-DESIGNER accurately predicts the Niyama micro-porosity occurring late in the solidification stage.

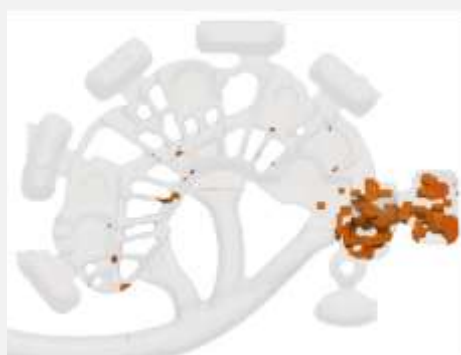
ACCURATE METAL FLOW SIMULATION



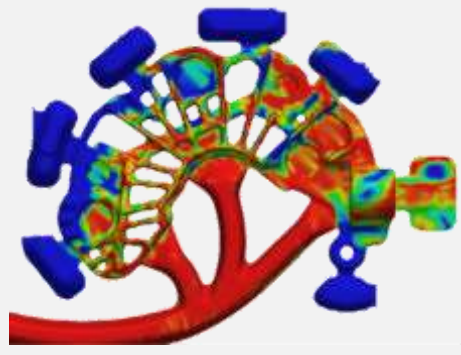
Short shot testing result and Cast-Designer simulation result of aluminum housing



(a) X-Ray photo of casting



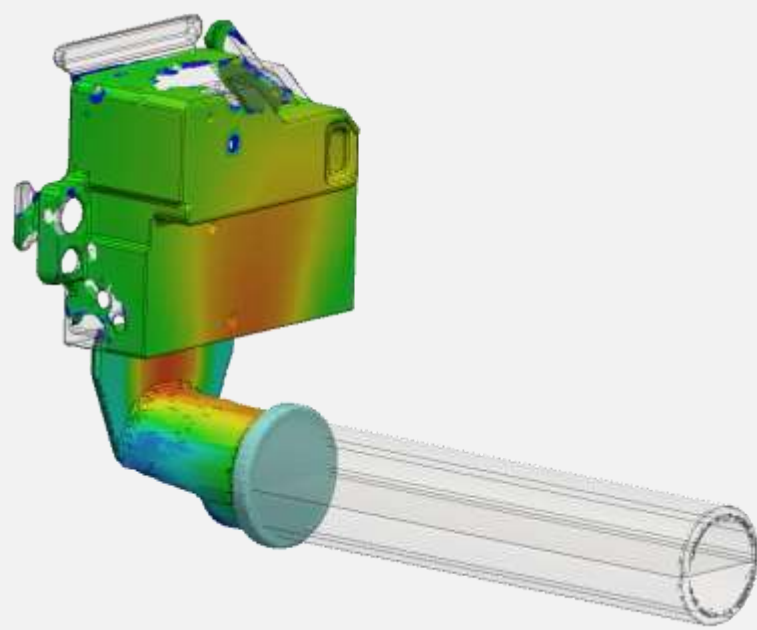
(b) Gas entrapment



(c) Flow pattern

SHOT SLEEVE PISTON MOVEMENT

CAST-DESIGNER has shot sleeve piston movement capability to exactly simulate the actual machine condition in the simulation. Useful to decide on first phase velocity and full shot curve.

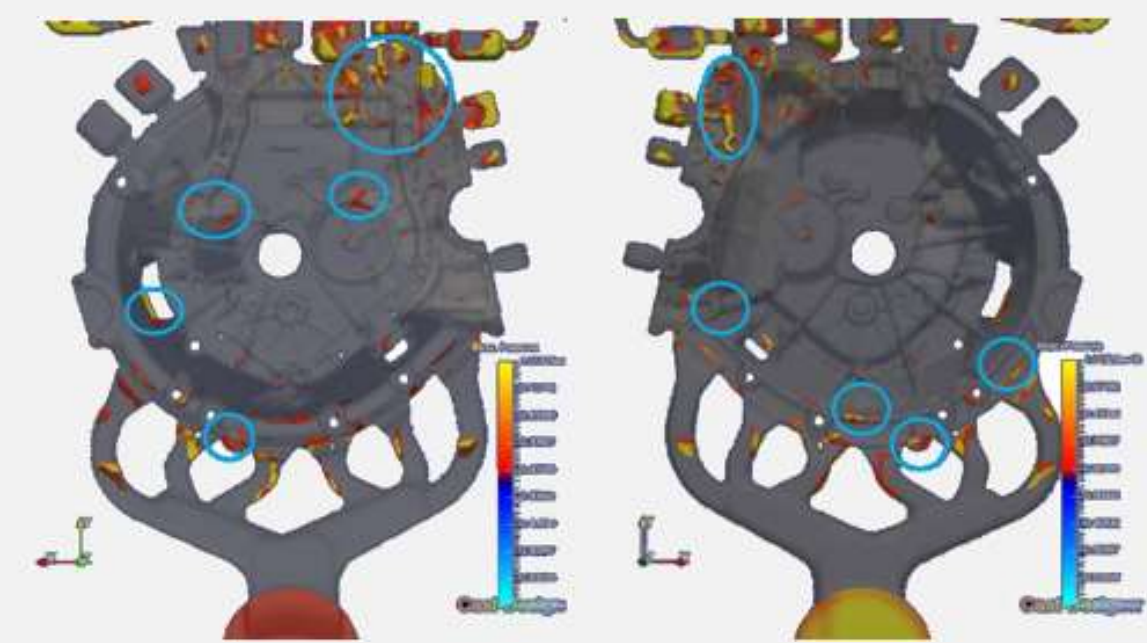


VACCUM, AIR VENTS

With accurate air back pressure calculations, CAST-DESIGNER can simulate the effect of air vents, vacuum or user defined environmental pressure conditions effectively. Provides volume and velocity of the air escaping through the air vents.

MAX AIR PRESSURE

CAST-DESIGNER provides regions with maximum air pressure which is important for designer to decide on the overflow and venting locations.



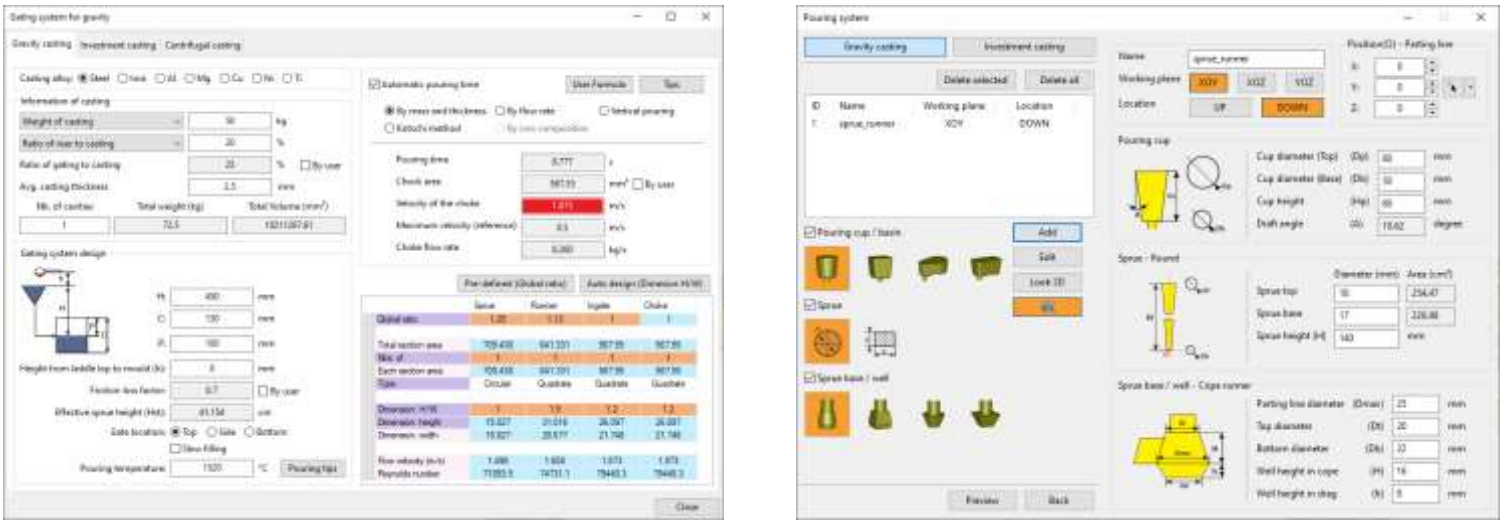
SQUEEZE PIN

Squeeze pins are used in die-casting to locally push the material to reduce shrinkage porosity. In CAST-DESIGNER the squeeze pins can be simulated to find its effect and decide on the timings and sizes for the squeeze pins.

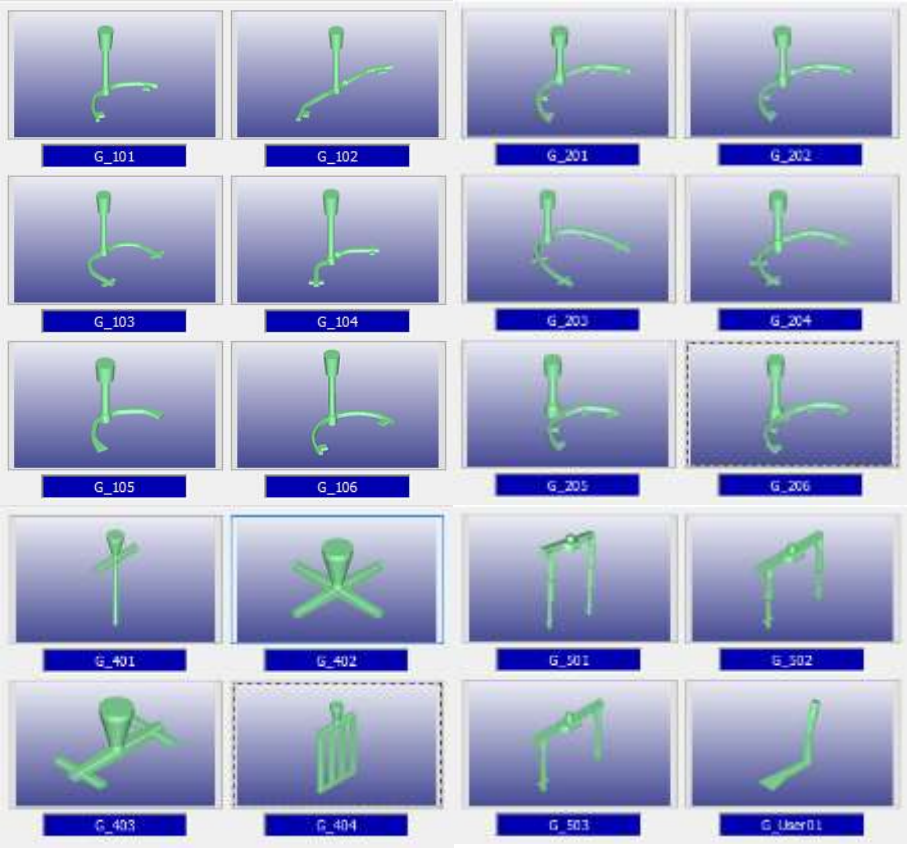
Comprehensive design and simulation capabilities for sand casting, permanent die casting, tilt casting, centrifugal casting, and low pressure die casting processes. Evaluation of gating, riser, chill & sleeve design for flow turbulence, mould erosion, porosity.

RISER & GATING DESIGN ADVISOR

CAST-DESIGNER has KBE (Knowledge Based Expert System), which has 50 years of industrial experience and industry standard recommendations.



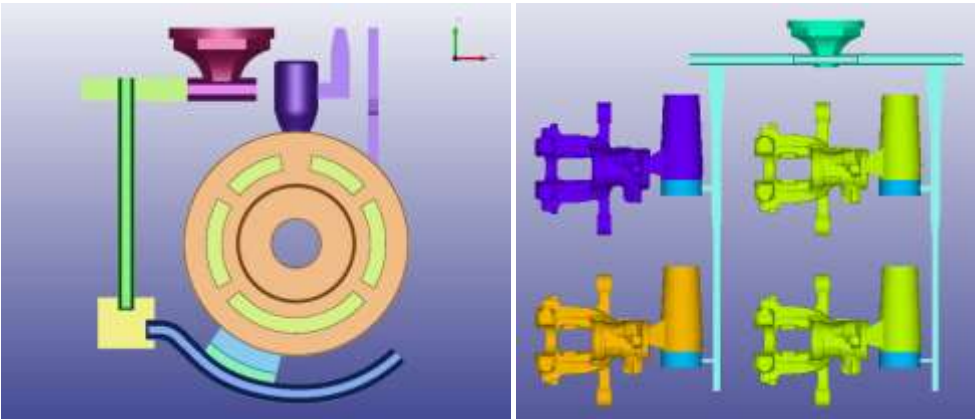
TEMPLATE GATING DESIGN



‘Template design’ is a useful concept and function to design casting system in expressway. Based on the pre-defined gating system template, the user can adjust the style and parameters in the table to generate a gating system in a few minutes. Both the design time and work load could be reduced to minimum.

DISA GATING DESIGN

CAST-DESIGNER has specially designed templates for DISA system



MATERIAL DATABASE

Over 400 standard materials in cast iron, steel, stainless steal, Nickel, Aluminum, non-ferrous materials in the database.

Vast collection of Sand Mould materials, Chills, filters, Sleeve etc

EXO-THERMIC & INSULATIVE SLEEVE MATERIAL DATABASE

CAST-DESIGNER has comprehensive standard databases of Exothermic and insulative sleeve material database from the major manufacturers. Use of such material in the simulation provides the real world effect sand predicts exact solidification and shrinkage porosity results.

MATERIAL DATA PROTECTION

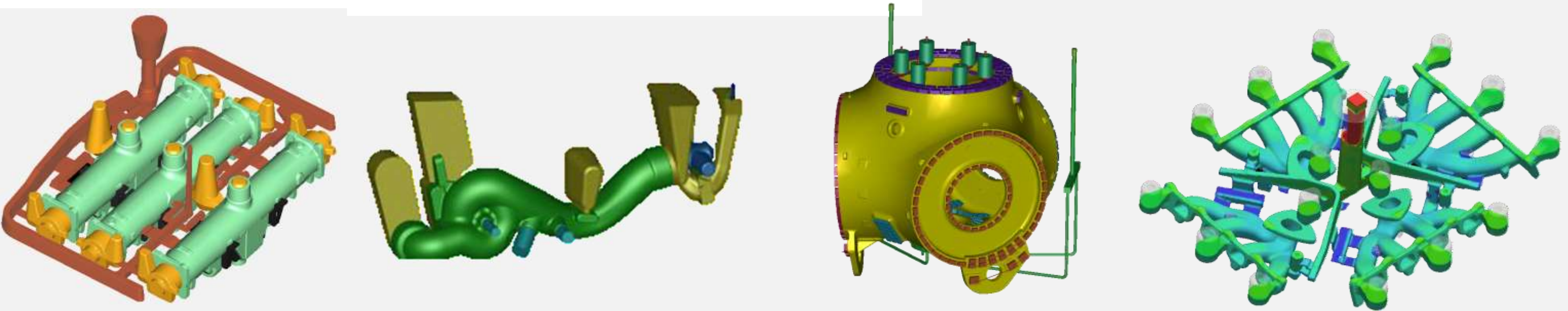
The user defined material could be protected by end-user. Such data could be copy and use, but could not be read out and modified without permission.

STANDARD PARTS LIBRARY

CAST-DESIGNER has library of standard parts like pouring cups, tilt pouring cups, DISA cups, Exo-thermic and insulative sleeves in different shapes and sizes. Helps user to quickly design the casting system.

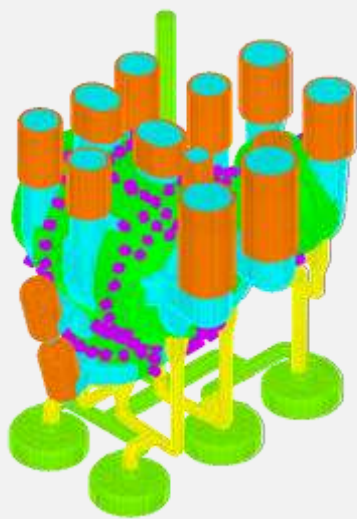
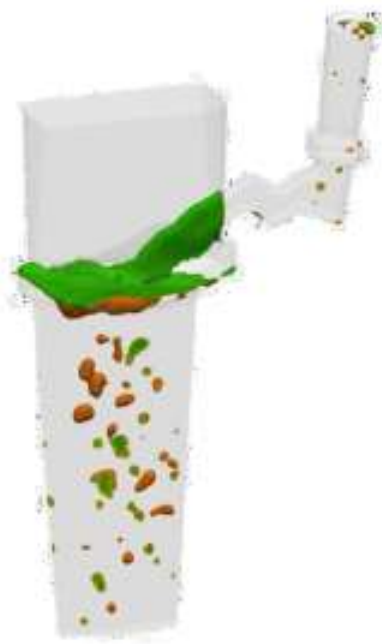
SMART RISER

A very useful riser design tool ‘Smart Riser’ has been integrated to CAST-DESIGNER to speed-up riser design.



TURBULANCE, OXIDES, AIR ENTRAPMENT, BUBBLE MOVEMENT

Slow filling or heavy temperature lose may cause cold-shut or pre-mature solidification or un-filling. The turbulence combined with high temperature during filling may lead to inclusions. Air bubbles in the heavy turbulence area forms oxide layers, that may get trapped in areas where fluid flow is restricted may create locally weaker region in the component. These defects can be precisely analyzed which helps designers optimize their gating system and better position for the vents & flow offs.

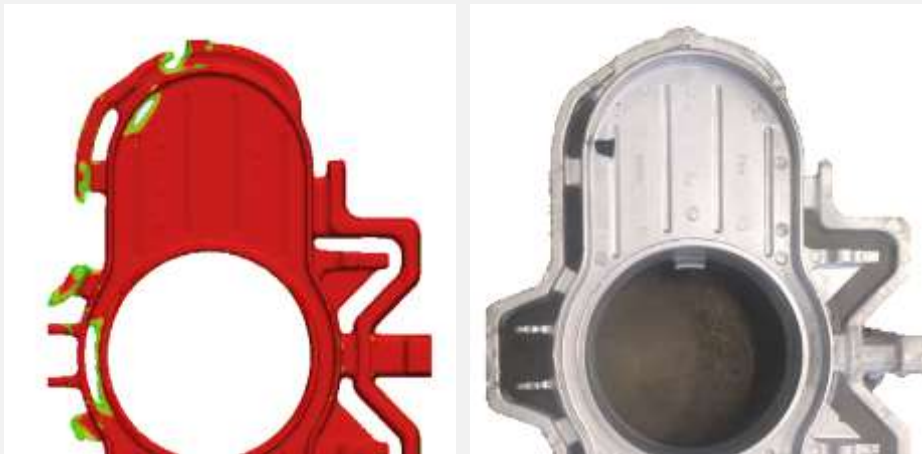


AUTOMATIC VARIABLE POURING

CAST-DESIGNER can automatically control the pouring rate of the liquid metal to match the practical conditions that maintains the liquid metal level with the specified minimum and maximum height in the pouring cup.

COLD SHUT & MISRUN

The temperature drop in the flowing liquid metal due to slow filling and cold mould, may lead to problems like un-filling, misrun, cold shut or pre-mature solidification. **CAST-DESIGNER'S** "full-couple" flow and thermal computation predicts such problems are accurately.



Regions of misrun and pre-mature solidification

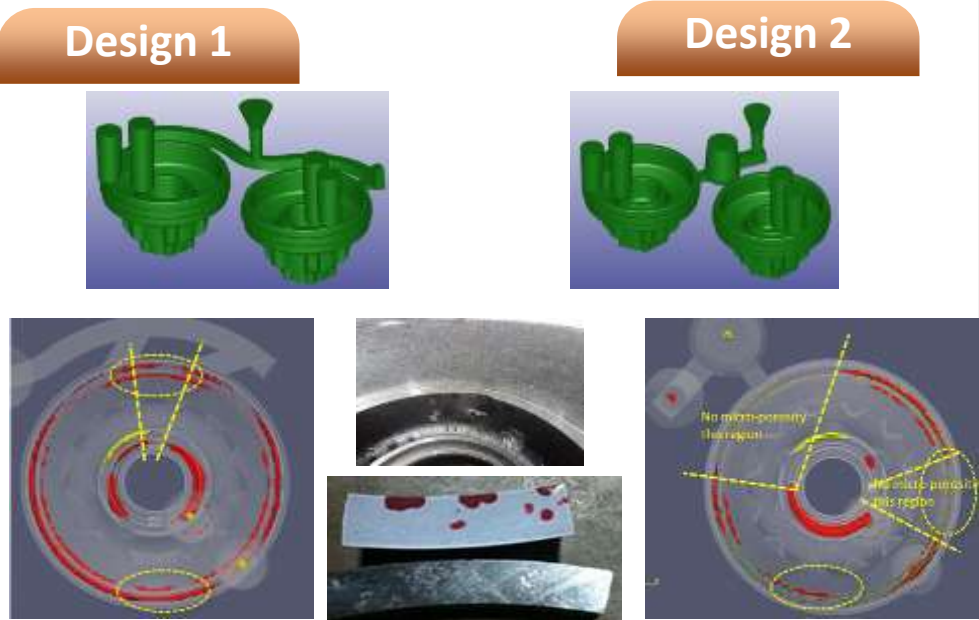
MOULD EROSION & SAND INCLUSION

High flow velocity, turbulences combined with high temperature causes mould erosion and the eroded sand is included into the molten liquid metal causing serious casting defects. **CAST-DESIGNER** can high light such potential areas in the simulation.

SHRINKAGE POROSITY & NIYAMA MICRO POROSITY

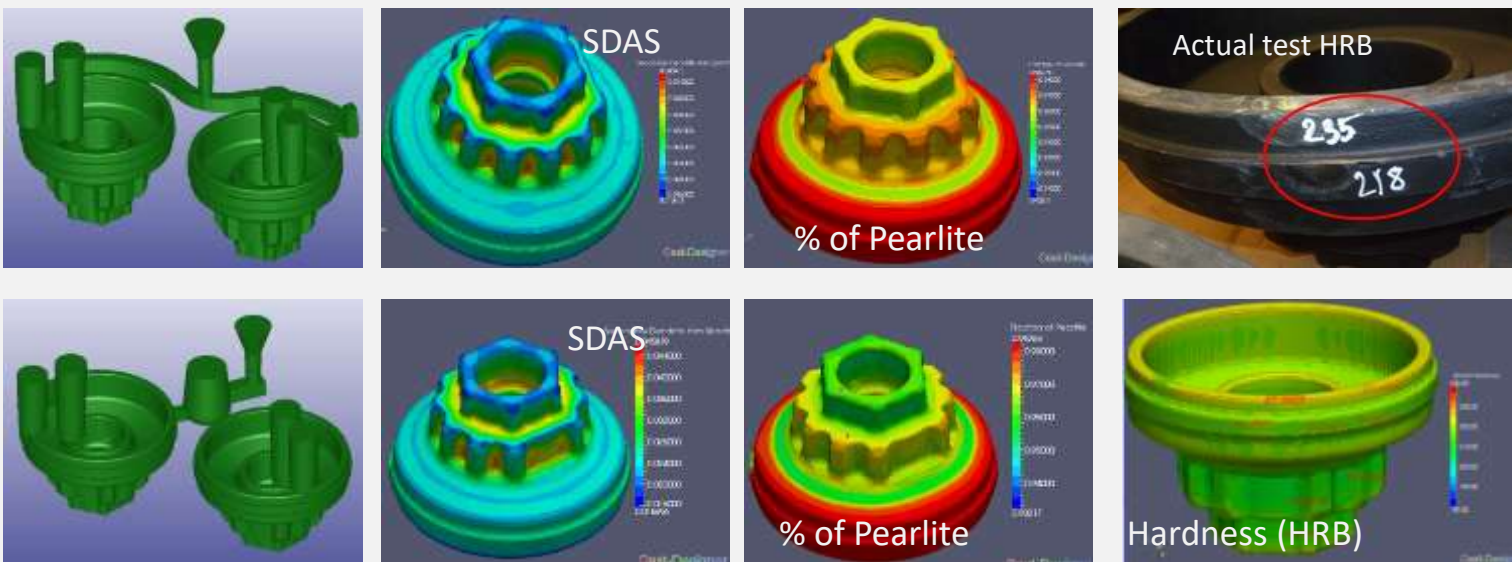
Accurately predicts the shrinkage porosity, taking into account of the expansion of cast iron and the density variations that occur during the cooling process in the solidification.

CAST-DESIGNER accurately predicts the Niyama micro-porosity occurring late in the solidification stage.



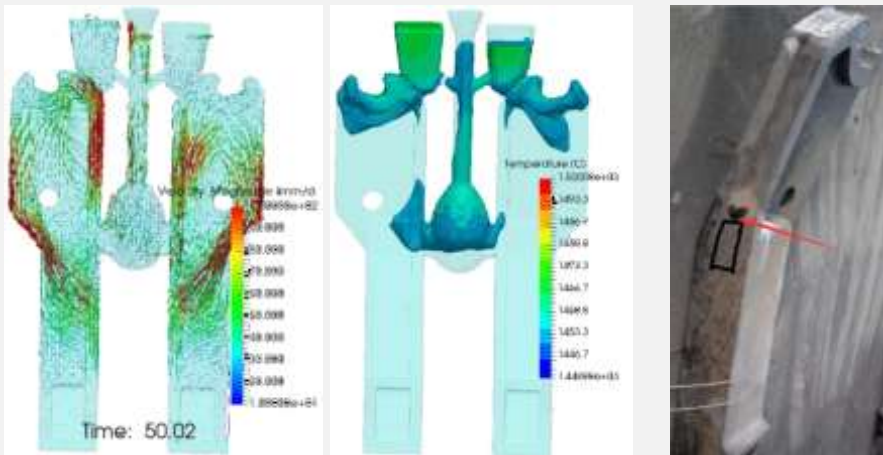
MICROSTRUCTURE ANALYSIS

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



BUOYANCY DRIVEN FLOW DURING SOLIDIFICATION

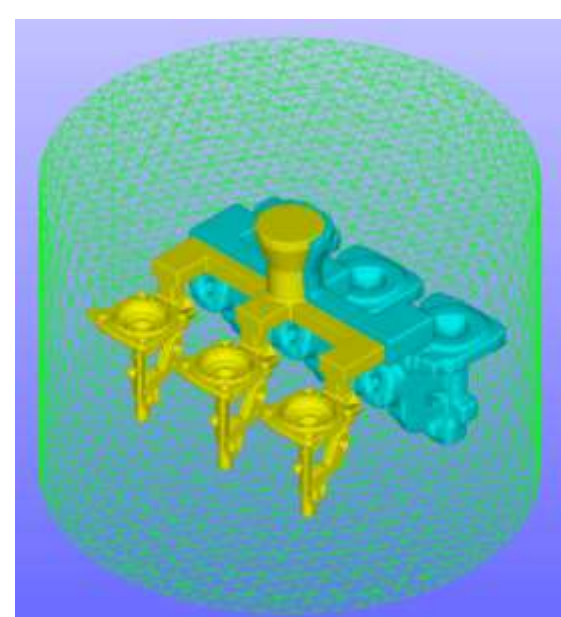
CAST-DESIGNER has can consider flow during solidification. It is common to shut the flow solver during solidification phase in casting simulation software, it is found that the buoyancy forces are driving flow during solidification. It moves the hot-spots and final location of the shrinkage porosity in big part.



For high temperature process like investment casting, the heat radiation must be considered in the simulation. The affection of shell and enclosure is important in radiation calculation, it must be modeled. View factor and shadow factor may change the solidification and porosity results.

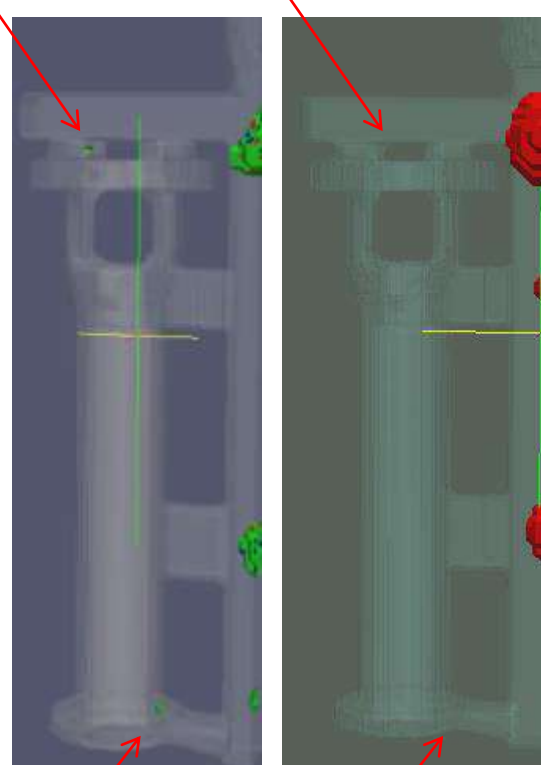
ENCLOSURE, RADIATION & VIEW/SHADOW FACTOR

- Even if no physical enclosure, the factory roof and wall is also a big enclosure.
- Due to the casting & gating geometry, somewhere will be shadow region for radiation simulation, so the solidification speed or cooling rate will be affected.
- The solidification time also affected by radiation.



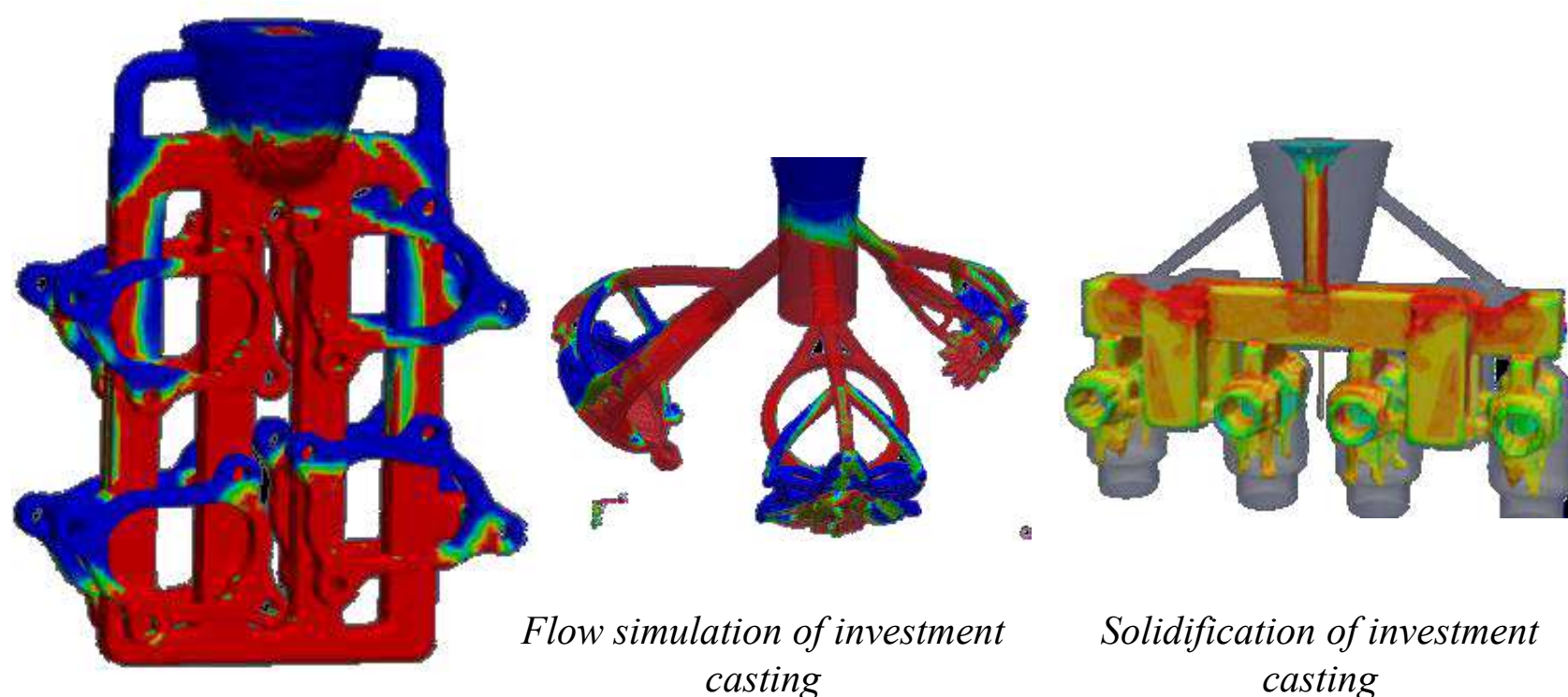
Radiation Effect in Enclosure

WITH VIEW/
SHADOW FACTOR WITHOUT VIEW/SHADOW
FACTOR



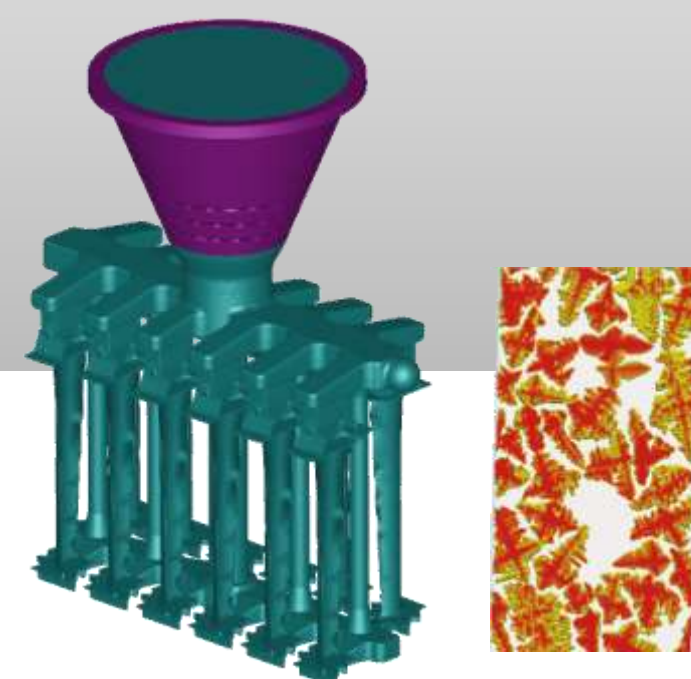
Shrinkage
Predicted

No Shrinkage
Predicted



Flow simulation of investment
casting

Solidification of investment
casting

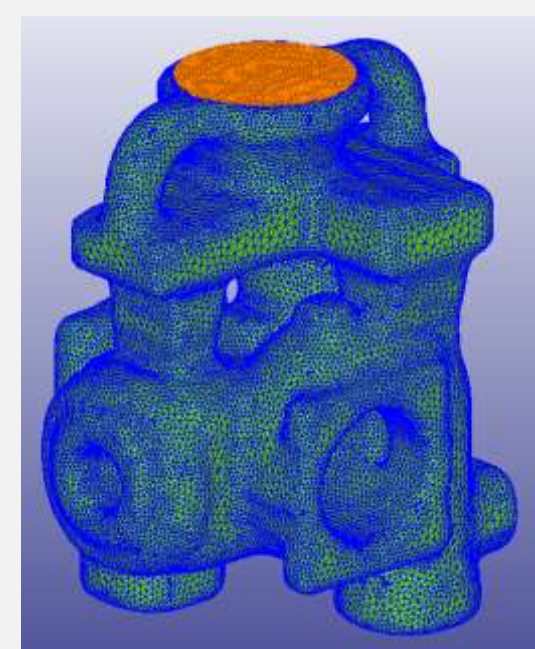


SHELL GENERATION

CAST-DESIGNER's automatic shell generation capability is very useful since the casting shell is very important for heat transfer, radiation and solidification in the investment casting process.



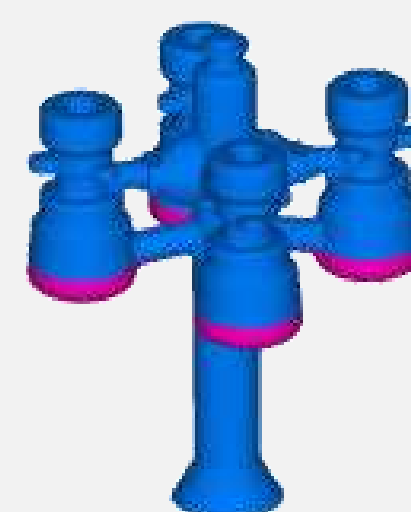
Casting CAD Model



Mesh for Casting and Shell

DEWAX ANALYSIS

Dewax function checks the casting geometry and identifies potential regions which could cause dewax issues. A casting system with good dewax design can improve the product quality and save energy.



Regions with dewax problem

LOCAL-GLOBAL MODEL

For some gravity casting/ investment casting model, due to the feature size was very fine and so many cavities, the standard simulation method is very difficult to handle that.

CAST-DESIGNER has developed a new method named 'Local-Global model' to solve this kind of problem:

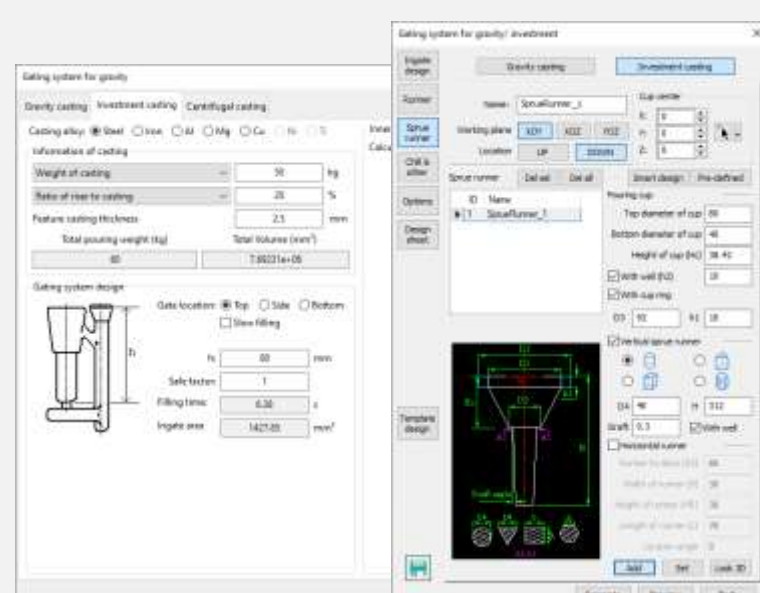
- The global model for general filling, thermal and solidification simulation. So a coarse mesh could be used to save CPU time.
- The local model could be used for detail filling of a local features in a very fine mesh, while the in/out velocity and temperature could be obtained from the global model as boundary condition.

In this case, it can save lots of CPU time and keep a high accuracy. This is the unique technology in the market today.

GATING DESIGN ADVISOR

CAST-DESIGNER is the sole system to guide investment casting system design in the market today

- The gating system designer could design any complex casting system in full parametric method
- Built-in knowledge base to assist the designer
- Riser, inner gate, runner, sprue runner and chill design, build in main tree type.
- Supports user defined template, flexible import and export template.



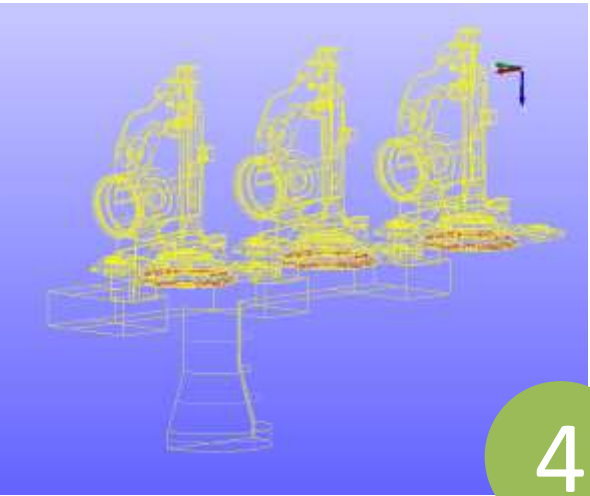
Gating Design Advisor for
investment casting



Smart Design for Investment Casting

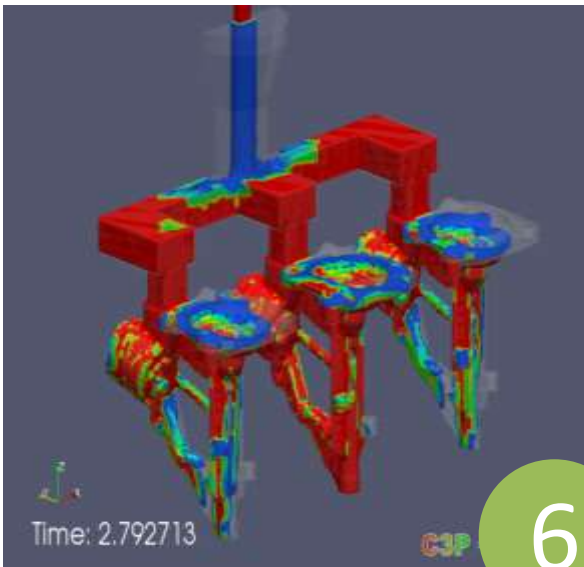
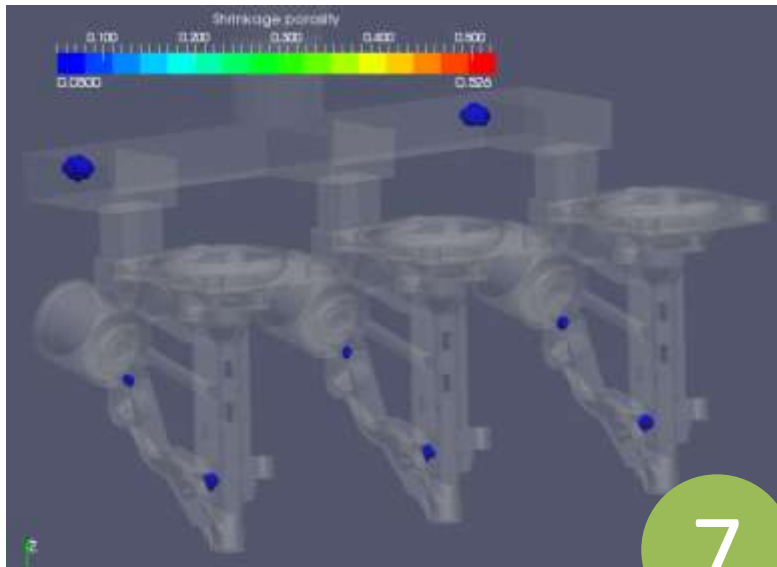
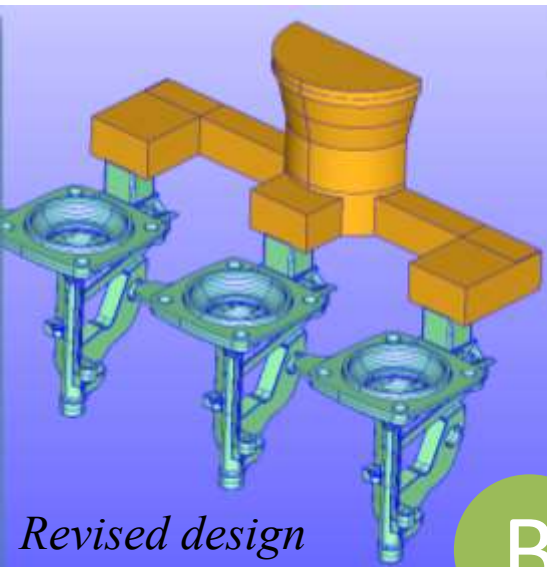
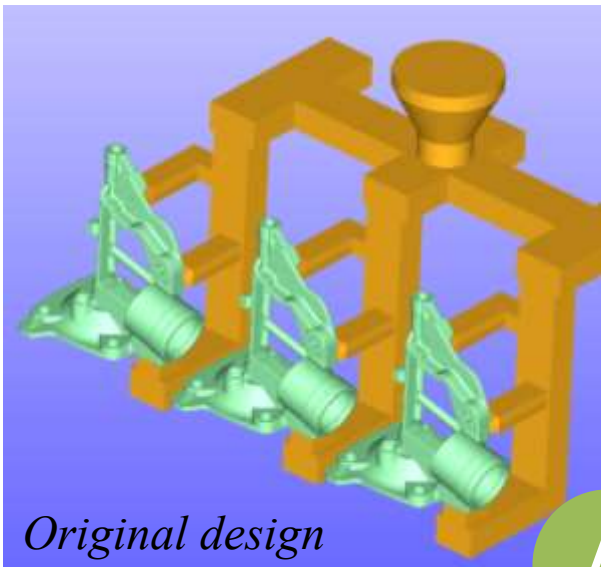
Input Casting weight (g): 4800 Tolerance: 100 Show All

B	HR	L	D1	W	D2	D4	H3	Hcup	H
33.30	20.00	100.00	70.00	4794.00	25.00	20.00	90.00	80.00	140.00
25.00	25.00	100.00	70.00	4857.00	25.00	20.00	90.00	80.00	145.00
37.50	25.00	60.00	70.00	4748.00	30.00	25.00	90.00	80.00	145.00
30.00	30.00	60.00	70.00	4783.00	30.00	25.00	90.00	80.00	150.00
60.00	30.00	80.00	80.00	4802.00	40.00	35.00	90.00	80.00	150.00
63.00	35.00	120.00	90.00	4842.00	45.00	40.00	90.00	80.00	155.00
45.00	45.00	135.00	90.00	4724.00	45.00	40.00	90.00	80.00	165.00
67.00	40.00	150.00	100.00	4829.00	50.00	45.00	90.00	80.00	160.00



INVESTMENT CASTING DESIGN & SIMULATION WORK FLOW

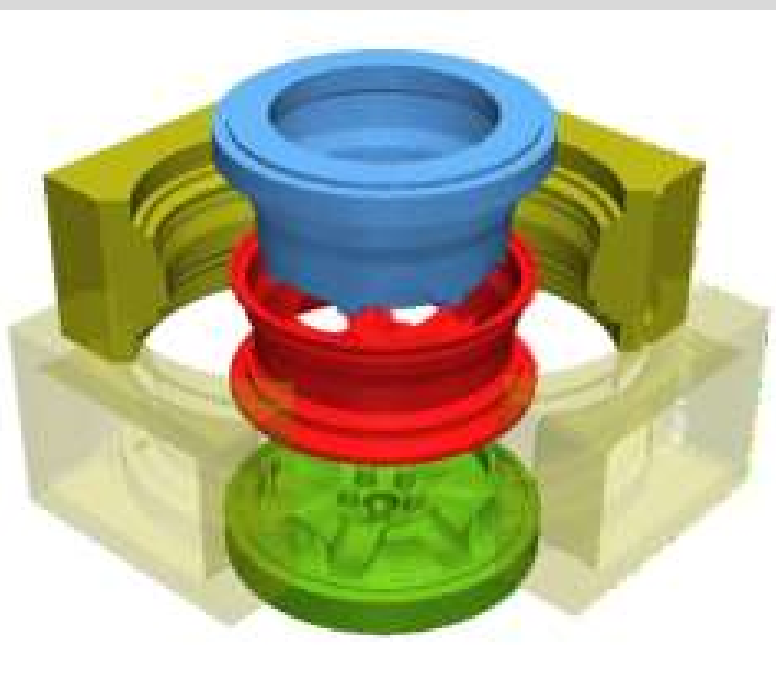
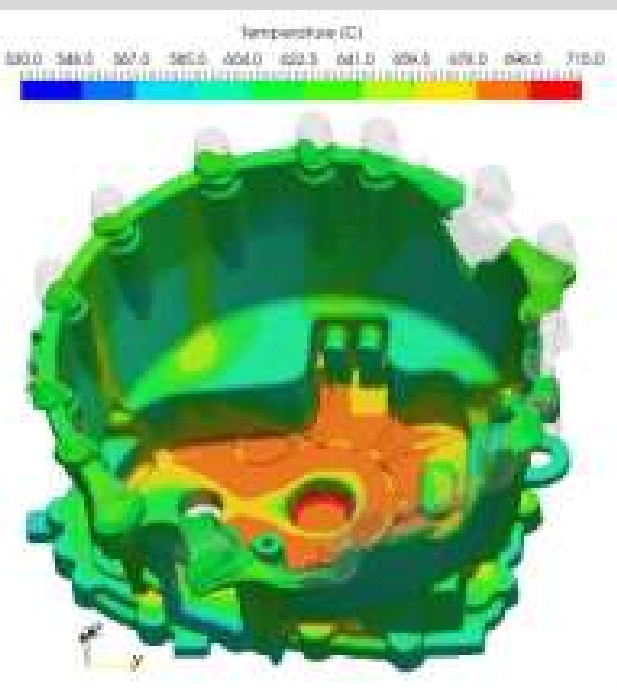
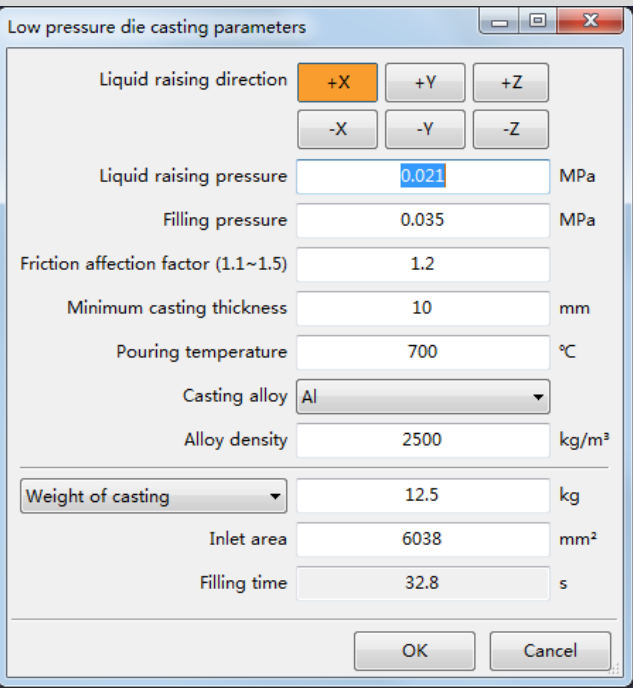
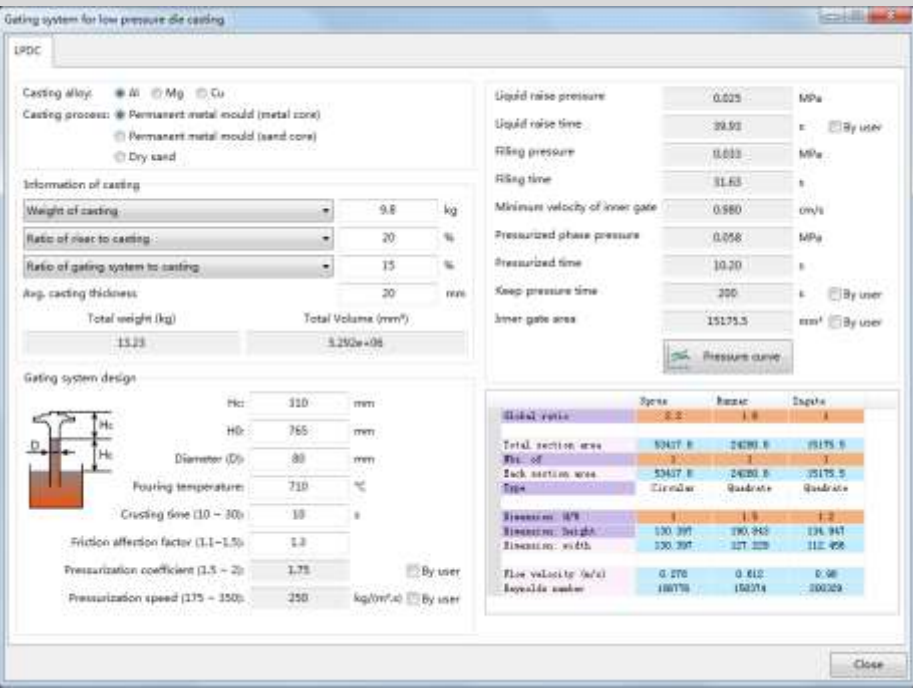
- (1) Analyze the casting part, check the MDI & HDI, define the position and size of inner gate
- (2) As the weight and numbers of the casting part to select the main tree in the smart design tool which is based on KBE
- (3) Generate the main tree and part layout
- (4) Dewax checking and adjustment
- (5) Shell generation and CAE analysis modeling
- (6) (7) CAE simulation result of flow (6) and shrinkage porosity (7)
- A, The old design with serious porosity problem
- B, The revised design plan in CAST-DESIGNER which save 38% of yield ratio, and the problem of shrinkage porosity has been solved.



LPDC DESIGN WIZARD

The design wizard for LPDC process can help design the pressure curve during the process, as well as the inner gate and runner design. The filling time, pressurize applying time and pressure are calculated by the wizard.

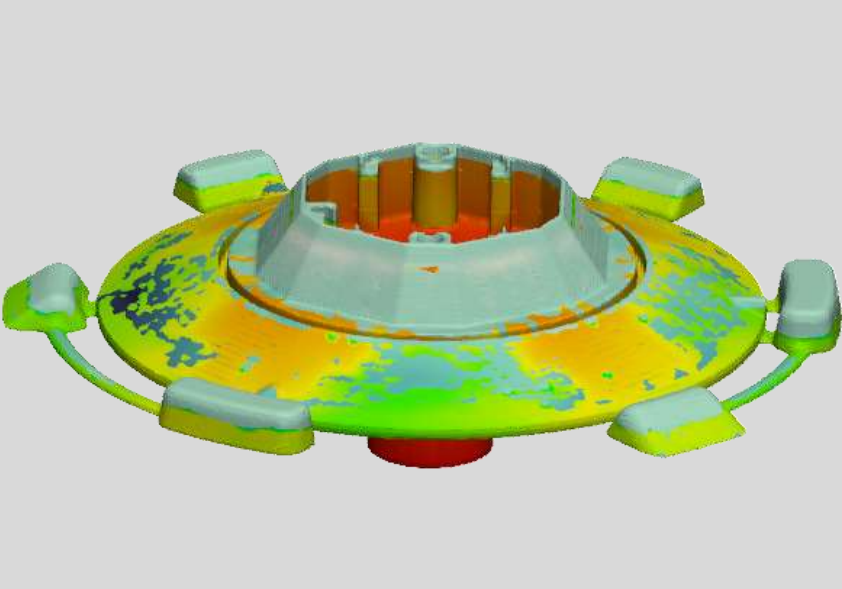
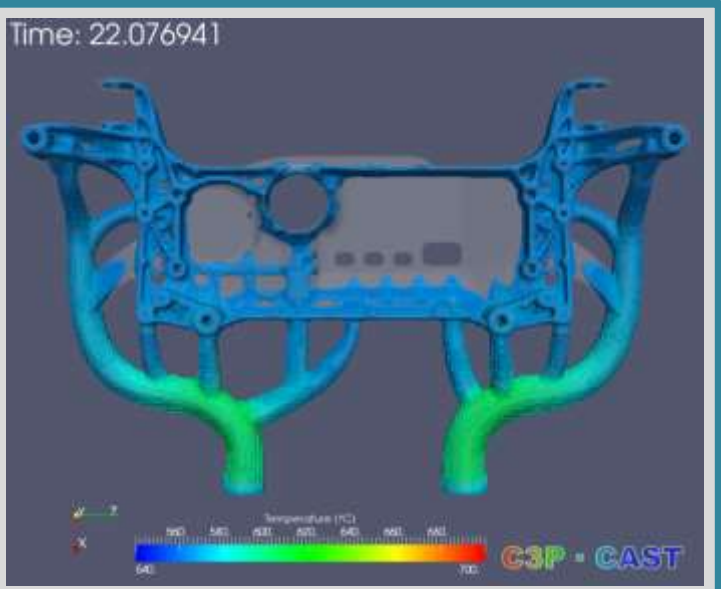
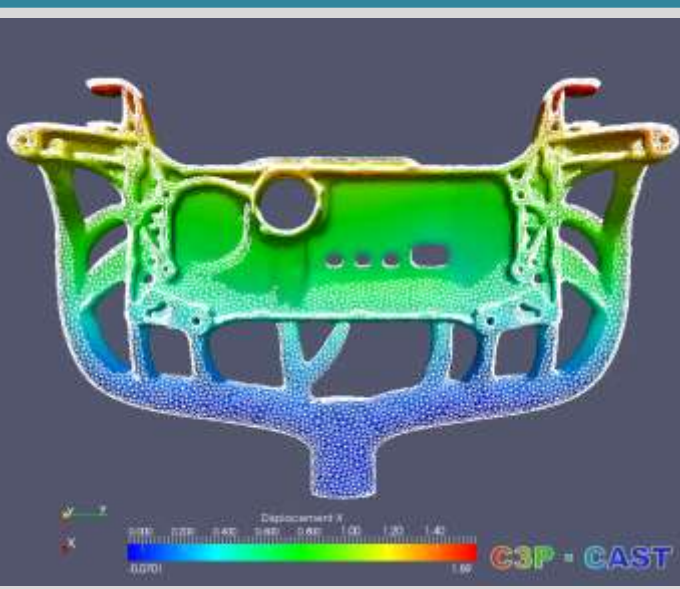
Low-pressure die casting process in CAST-DESIGNER module supports, variable pressure inputs in the inlet to simulate actual practical condition, the friction factor between metal and mould also was taken account. Thermal balance of the mould is very important for LPDC dies, various cooling channels and water or air spray mechanisms are used in the industry. The opening time, closing time of the such cooling mechanism plays vital in maintaining thermal balance of the mould.



LPDC Design wizard and Pre-defined analysis setup templates available for most of the casting processes. Above showing for LPDC process

LPDC Part filling

Typical LPDC mould for wheel casting



Full mould modeling & simulation

Different design plans for automotive part, to simulate the porosity and part deformation after casting

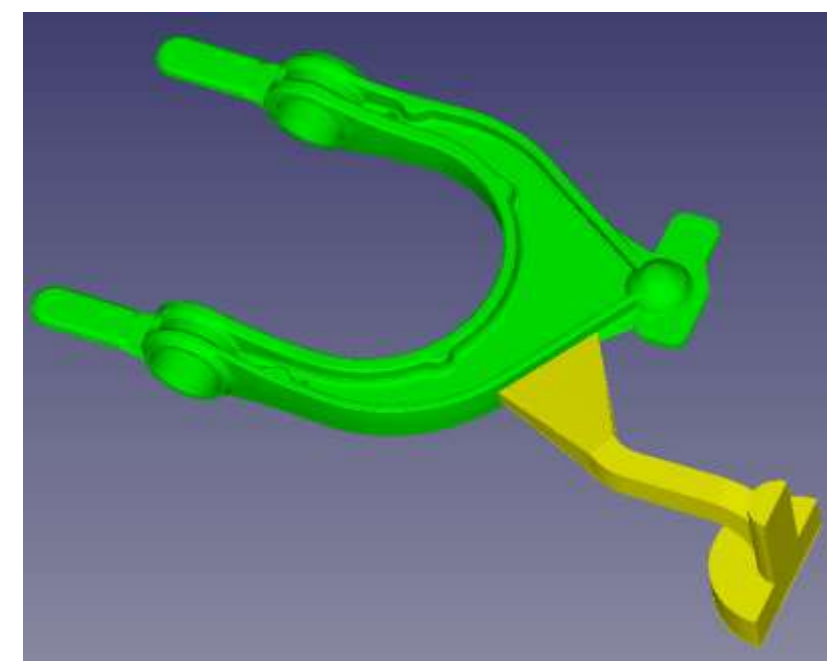
Temperature and pressure distribution of the filling process

SEMI-SOLID MODELING SIMULATION

CAST-DESIGNER

Typically, all semi-solid metal casting processes have critical small process windows, so mould concept and layout of the casting process have to be developed much more accurately than in “normal” metal casting. **CAST-DESIGNER** could be used for several various physics of semi-solid modeling with different numerical models, such as non-Newtonian flow. The semi-solid module could be used for,

- What are the right casting temperature, fraction solid and flow velocity?
- What are the suitable mold tempering approaches?
- How do melt viscosities, flow velocities, local fraction solids and local temperatures of the melt develop during filling?
- What is the shortest possible cycle time?

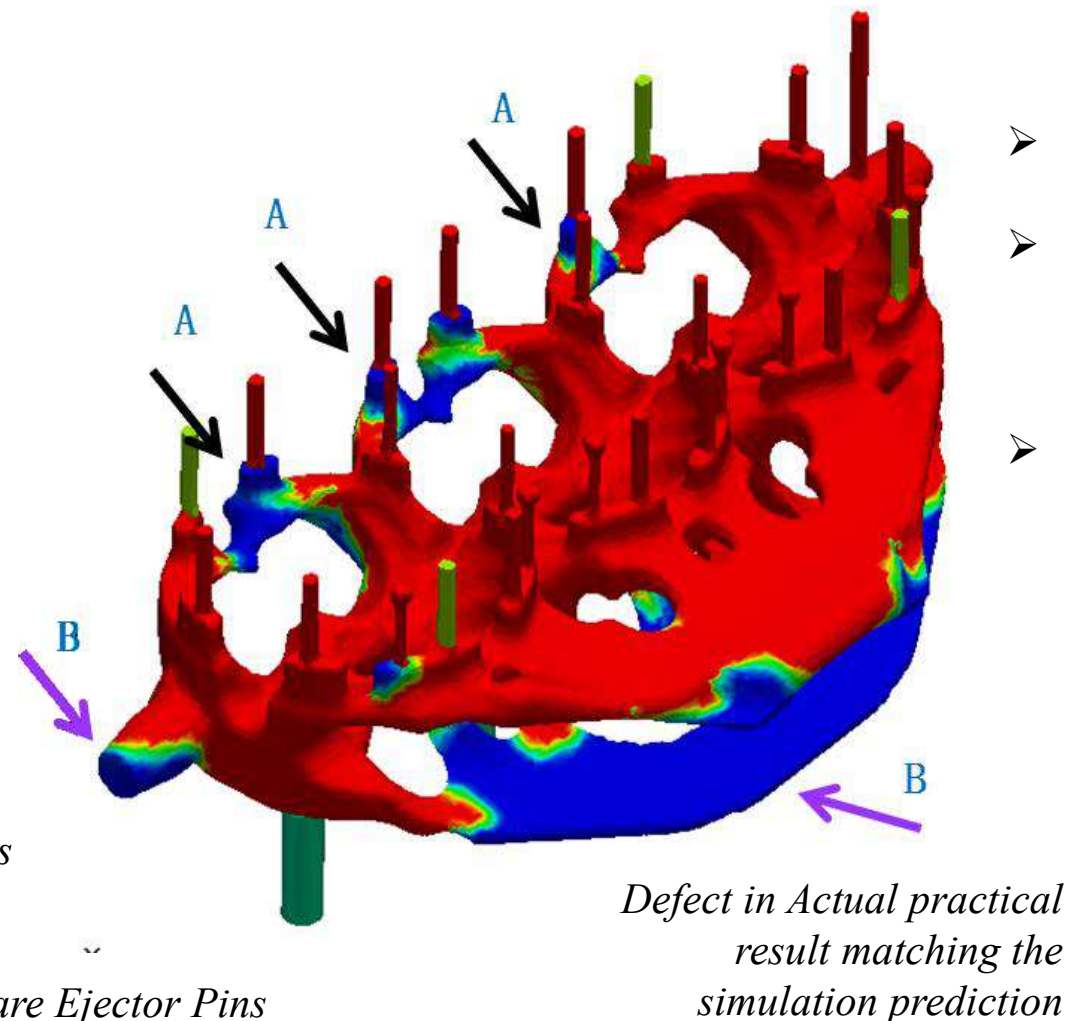
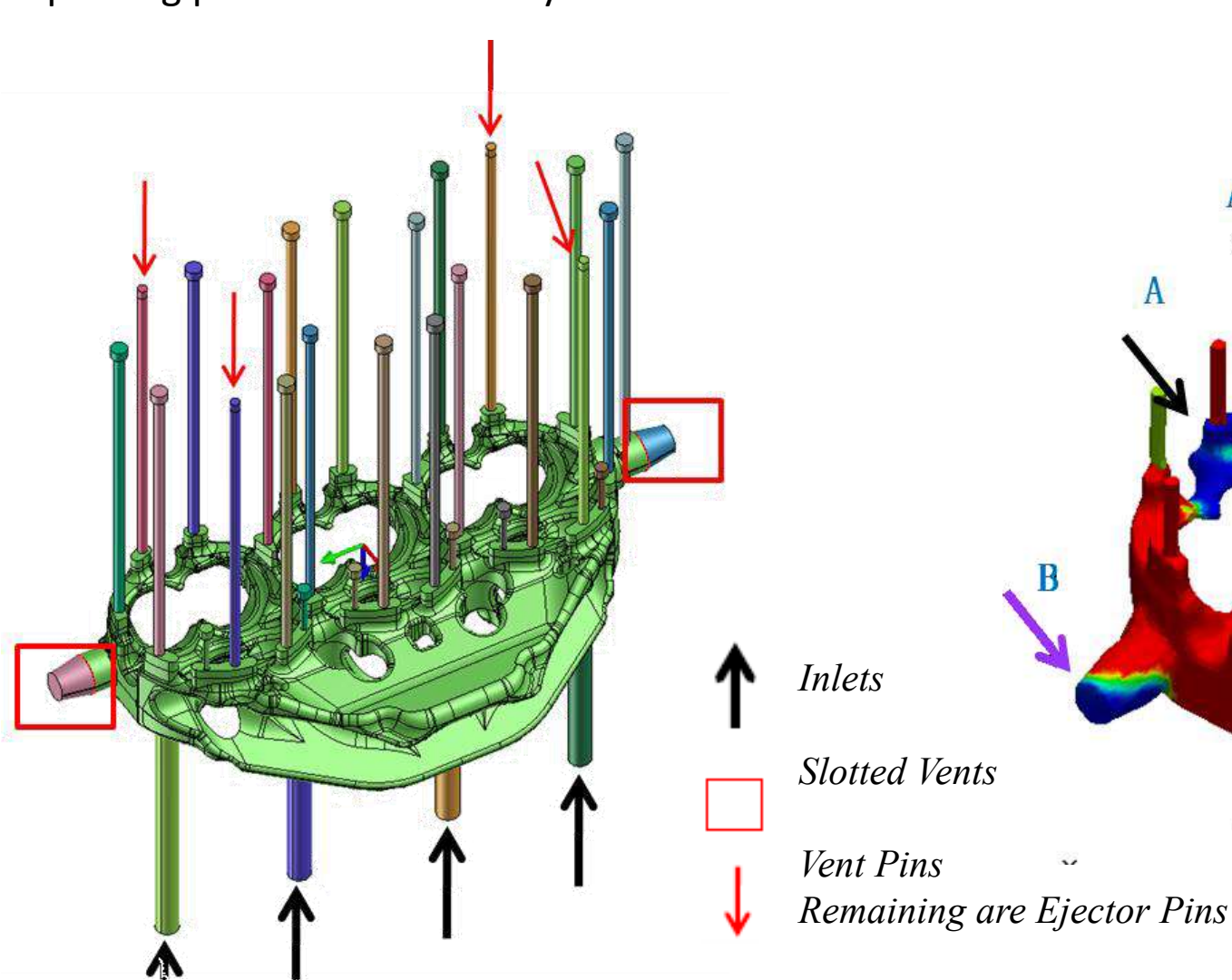


Thixo-Casting model

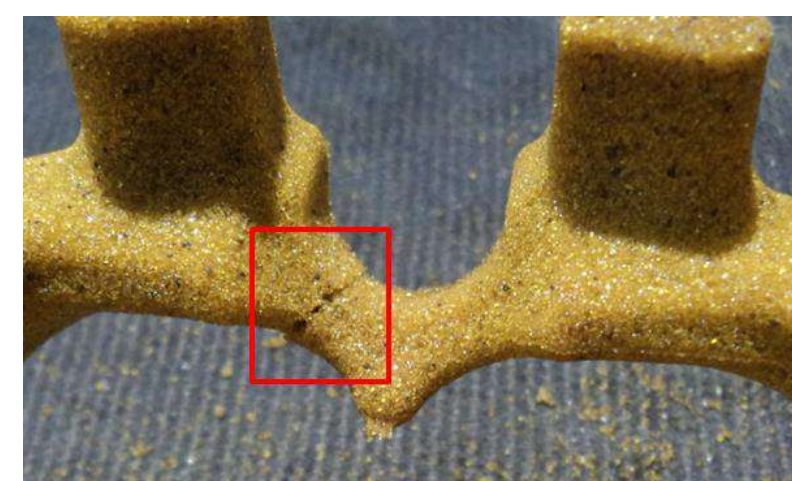
CORE BLOWING SIMULATION

CAST-DESIGNER

CAST-DESIGNER's core blowing analysis allow the user to obtain the optimum nozzle configuration by varying the number and position of the nozzles through which the sand is blown in and also the number and position of venting nozzles through which the air escapes. Also, find the packing pressure and density of the sand.



- **Region A:** filled last and gas could not be escaped, so may cause defects, i.e crack;
- **Region B:** filled last, but due to the vents and slider, the gas could be escaped, it do not bring defects.
- **Solution:** add vents to region A.



Air entrapment observed

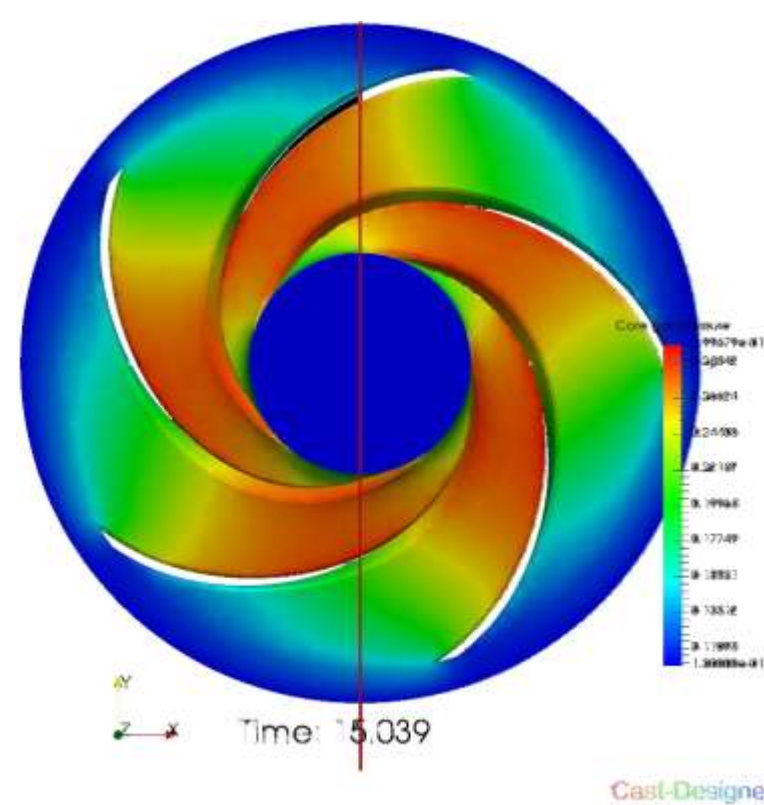
CORE GAS SIMULATION

CAST-DESIGNER

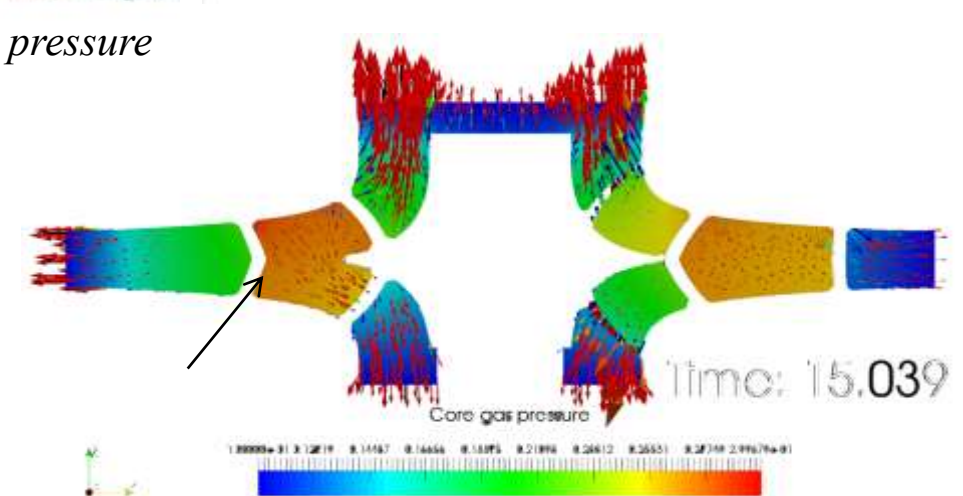
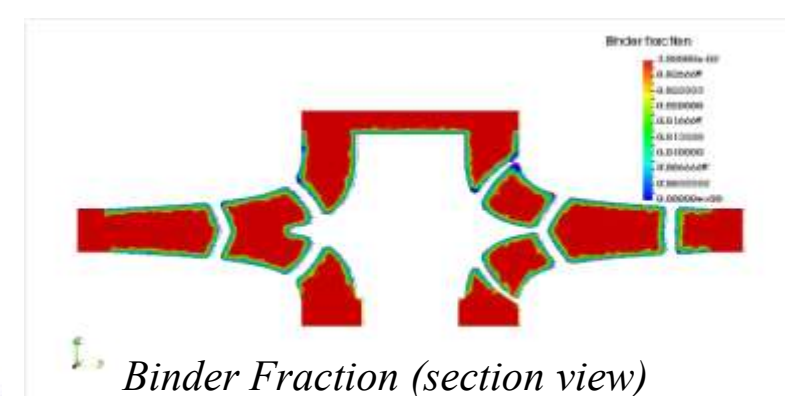
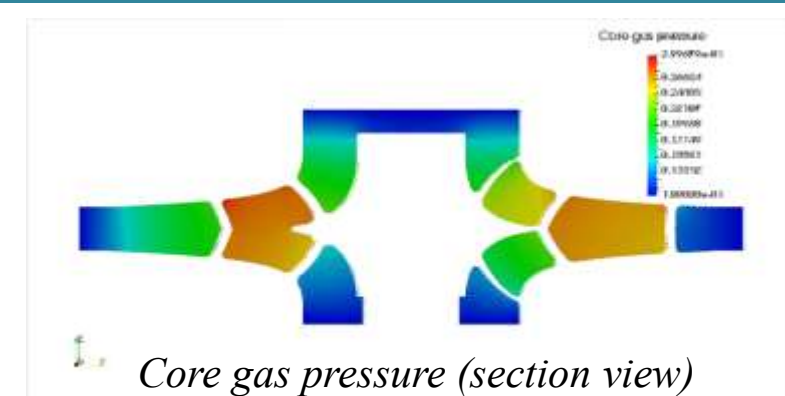
Chemical binders in the sand can produce gas when heated by the molten metal and if not vented adequately, the gas may flow into the metal resulting in a gas porosity defect.

CAST-DESIGNER's the core gas model is designed to predict the possibility of such gas defects and is intended to help design core venting that would evacuate safely all the binder product gas from the cores.

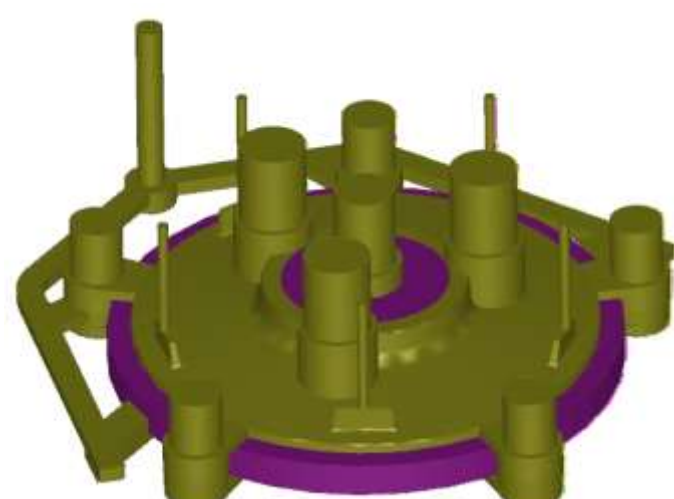
Example: The core gas can escape from the top, bottom and outside, but in the centre of the core is very difficult. So it will bring risk to the casting part for gas porosity. A solution is add venting inside the core.



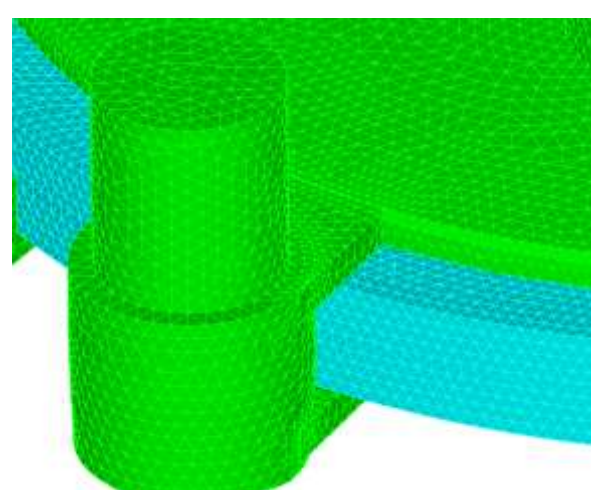
Core gas pressure



Risk! High pressure but lower velocity



Casting + Core

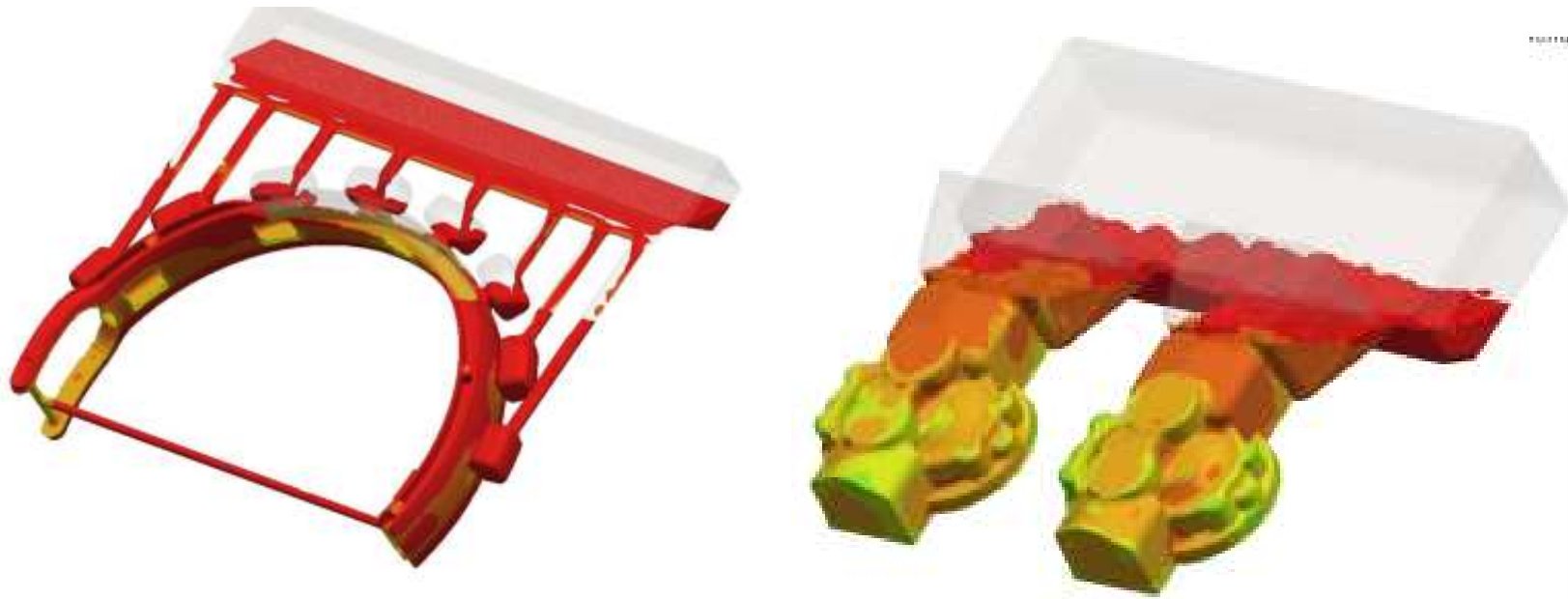


Mesh model (detail)

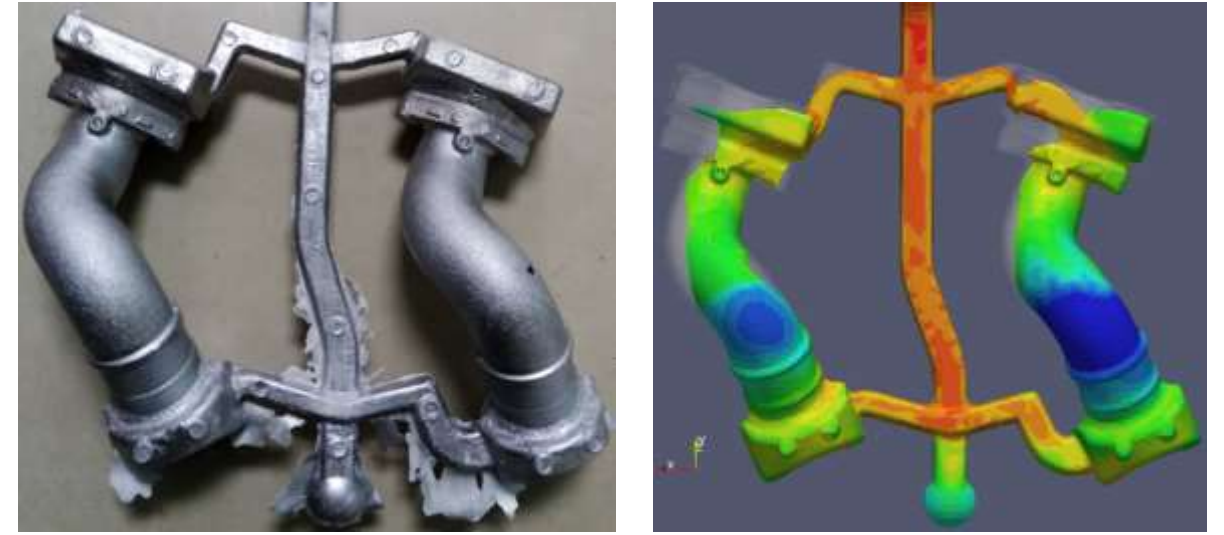
TILT POURING CASTING

CAST-DESIGNER

CAST-DESIGNER Gravity module has complete set of dedicated tools to model tilt pouring casting process. The gravity direction, rotation axis and rotation velocity must be defined. Dedicated pouring cup design wizard helps the user to design pouring cup quickly.



Tilt Pouring Examples

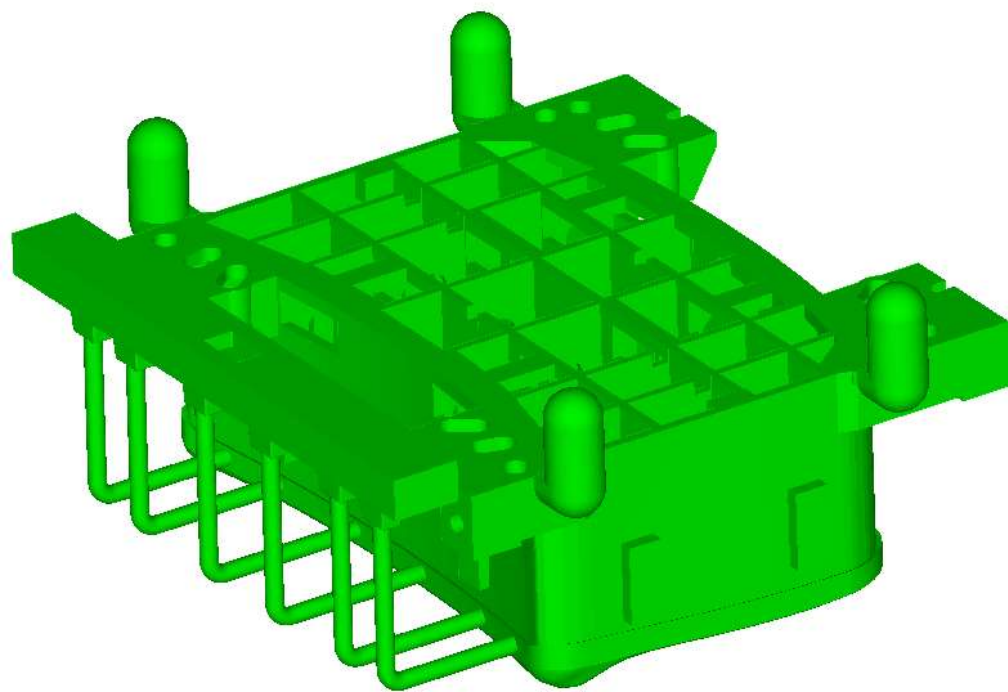


Tilt casting process

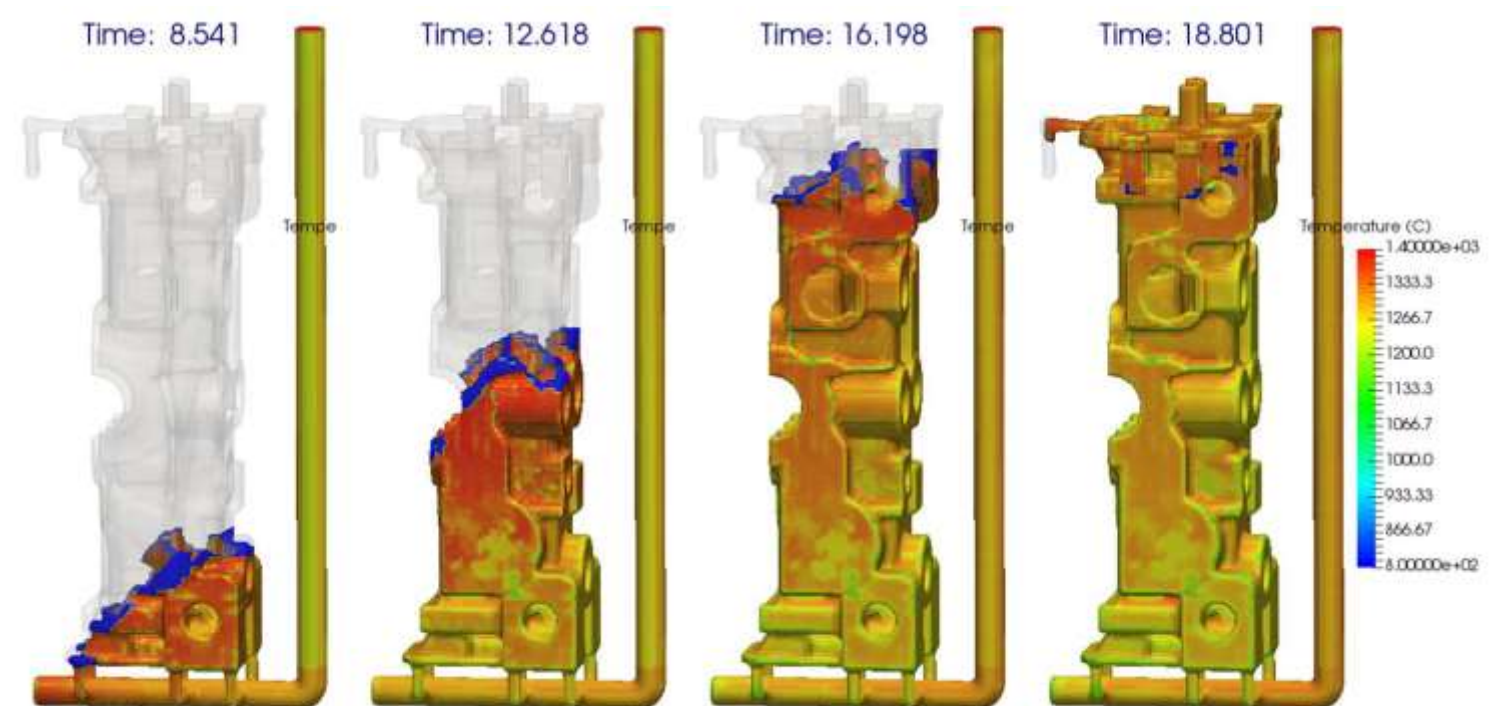
LOST-FOAM CASTING

CAST-DESIGNER

For Lost Foam Casting, since we need consider the gas pressure of the burned foam, we must generate the mould mesh with connect interface.



Lost foam casting for stamping die set



Metal flow filling sequence in Lost-Foam casting process showing flow temperature

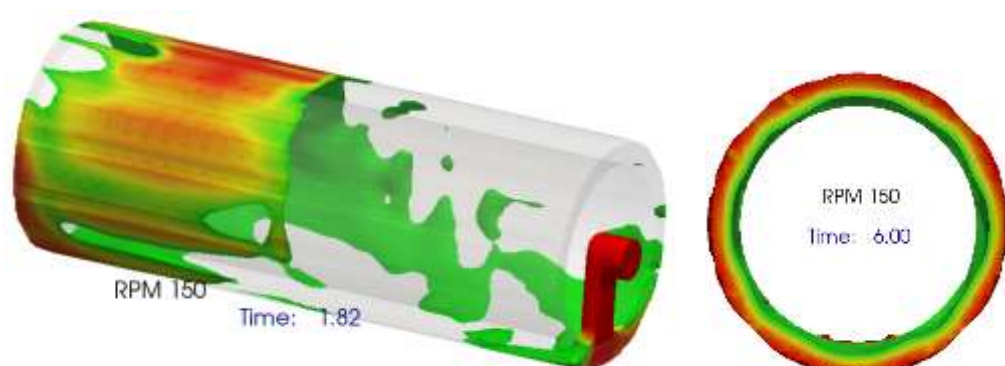
OTHER CASTING PROCESS

CAST-DESIGNER

CENTRIFUGAL CASTING

In centrifugal casting, a mold is rotated at high speed while the molten metal is poured into it. The molten metal is thrown radially outwards to the interior of the mold, where it solidifies as it cools. **CAST-DESIGNER** can prescribe this rotation with the ability to modify its speed and the location of defects, producing highly-accurate simulation results.

Both the vertical centrifugal and horizon centrifugal castings process could be simulated by **CAST-DESIGNER**.



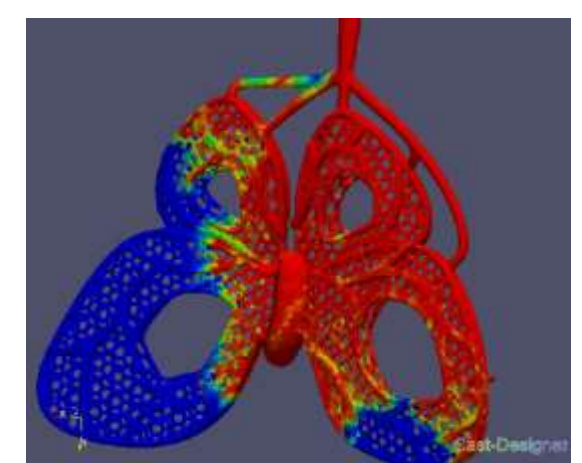
CONTINUOUS CASTING

Continuous casting is the process where molten steel is solidified into semi-finished billets, blooms, or slabs for subsequent rolling in finishing mills. In continuous casting, liquid steel is transferred in a ladle to the casting machine. When the casting operation starts, the sliding shutter at the bottom of the ladle is opened and the steel flows at a controlled rate into the tundish and from the tundish into one or more molds.

CAST-DESIGNER 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.

JEWELRY CASTING

CAST-DESIGNER allows engineers to explore and optimize foundry design concepts quickly and efficiently. A wide spectrum of foundry processes can be modeled and optimized using **CAST-DESIGNER** including casting of precious metals in order to make jewelry. In the jewelry industry, where perfection is key, so highly accurate filling and solidification simulations predict critical jewelry casting defects including surface oxides, air entrainment, shrinkage, and porosity.

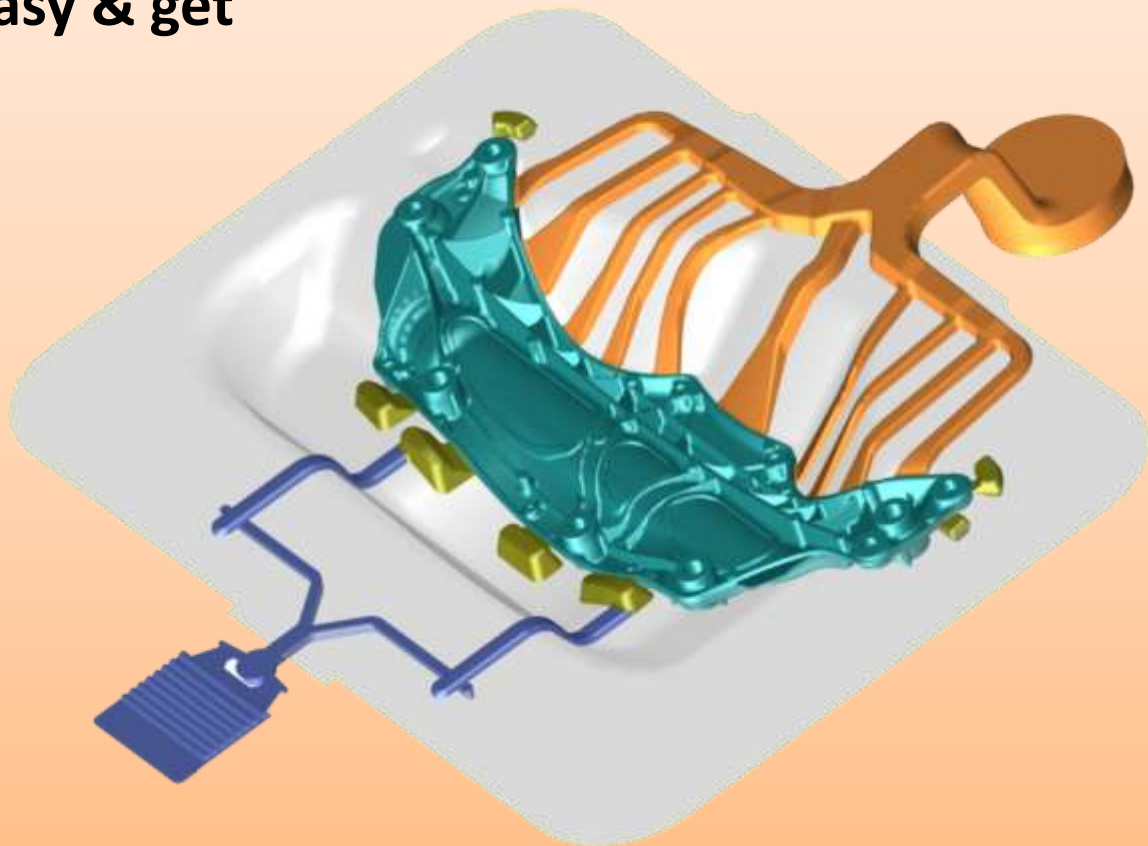


Working in “Free-Style” gating design module is fun and easy & get your design done in minutes.

4

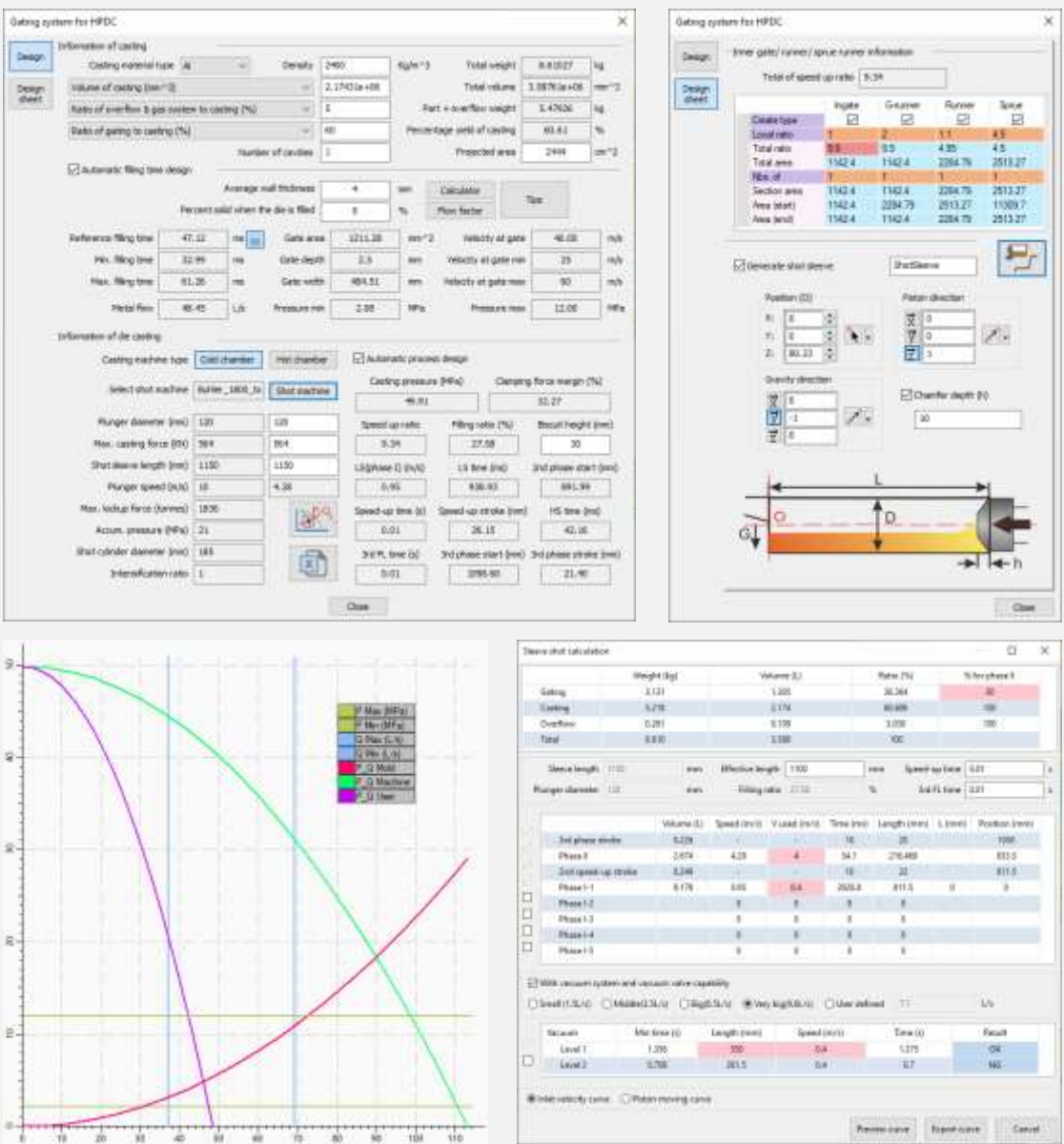
It’s like drawing on a paper

STEPS IN FREE STYLE DESIGN

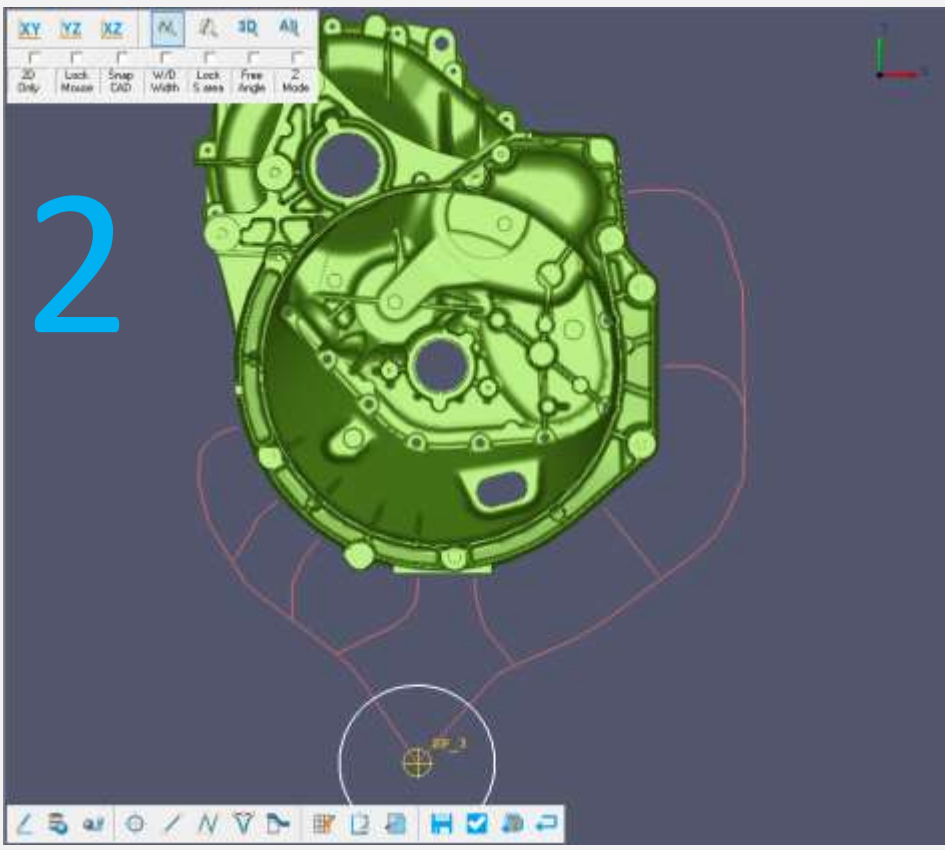


Draw directly on the 3D gating system

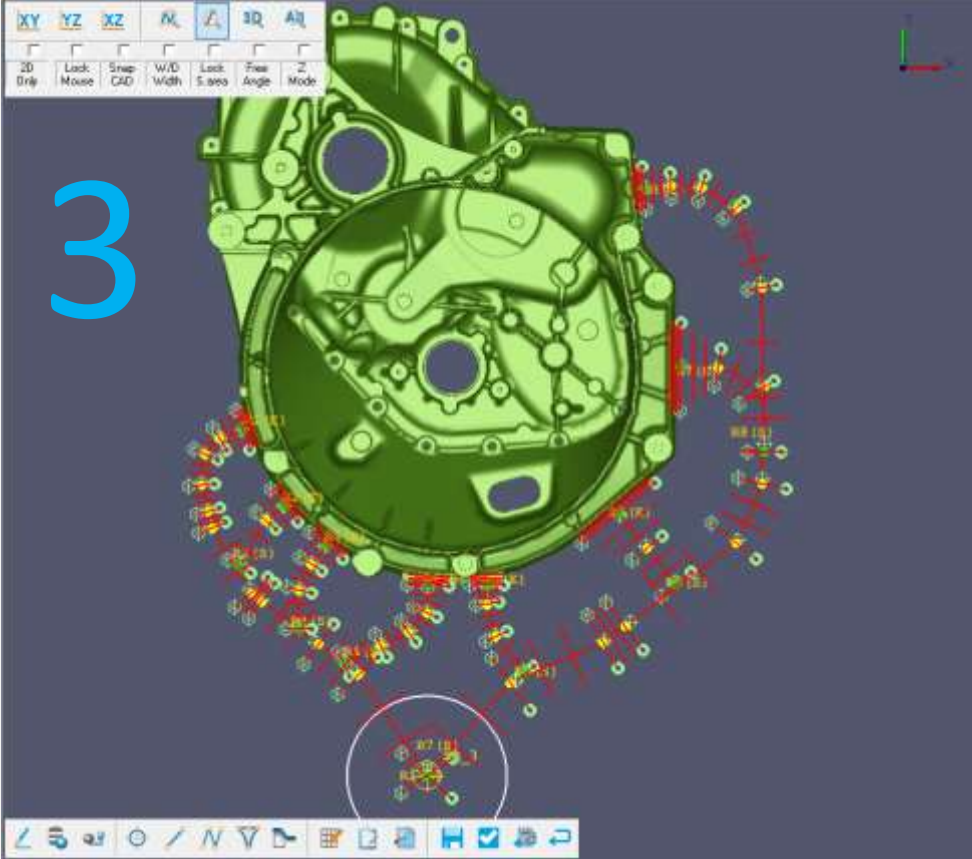
- ‘Free-Style’ gating design tool has intelligence about the standard definition of different runner shapes.
- By simply picking few points on the parting surface a spline created as a projected 3D spline.
- Taking this spline as controlling center line, runner geometry is created in 3D with required draft, rounds etc.
- 3D runner is always created as a swept blend with smooth bends.
- Based on the designed local speed-up ratio, runner section’s start area and end areas are controlled.
- Free design also supports pre-defined template library. The customize tool can help user to make customization in a few clicks.



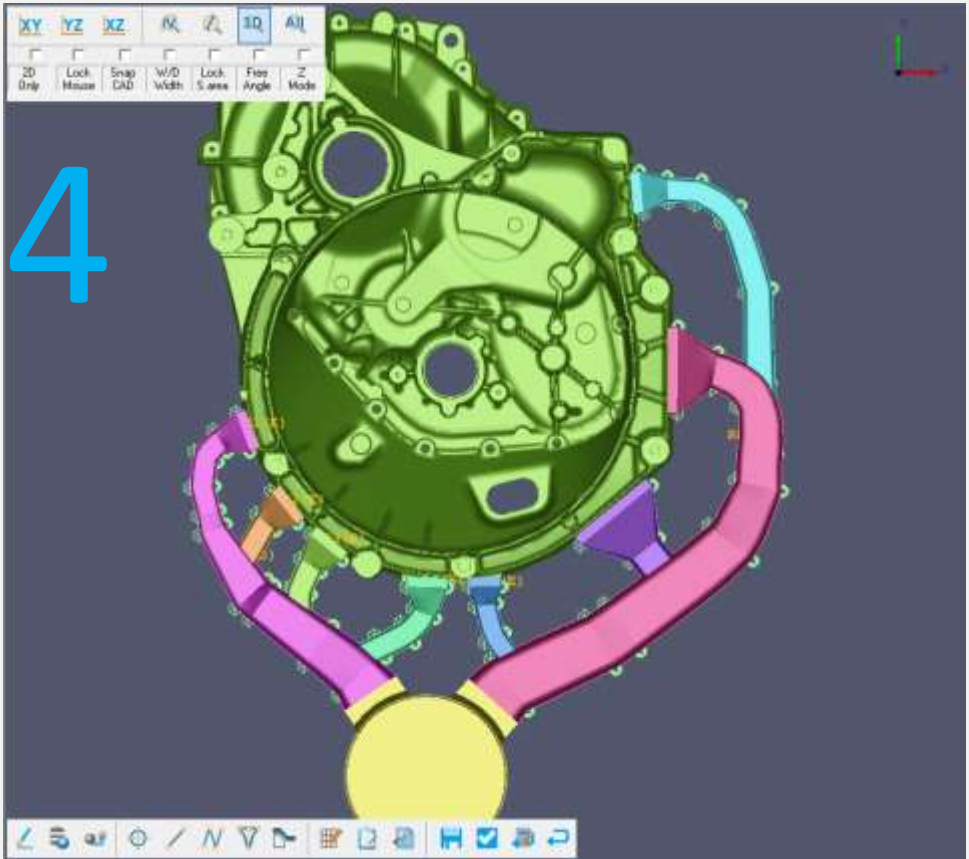
Get Design from Gating Design Wizard



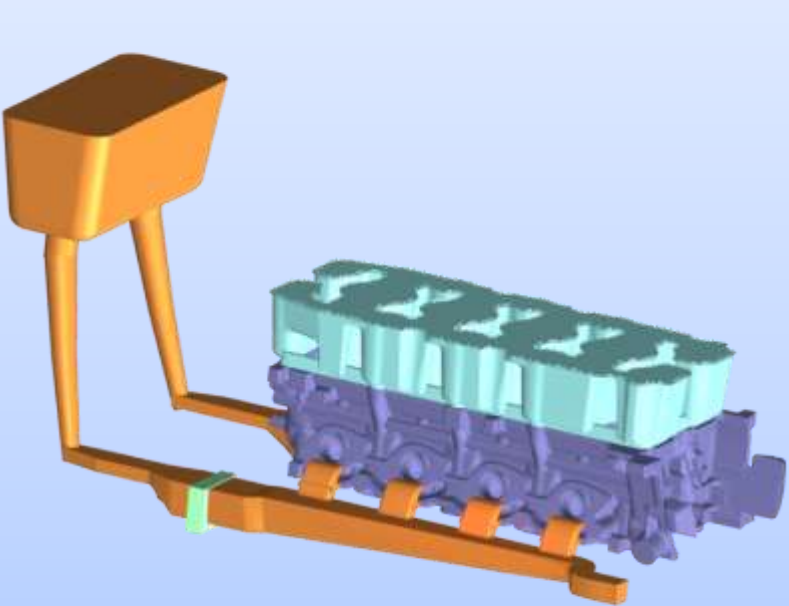
Draw your concept lines using 4 simple tools – main runner, runner, gate runner and sprue



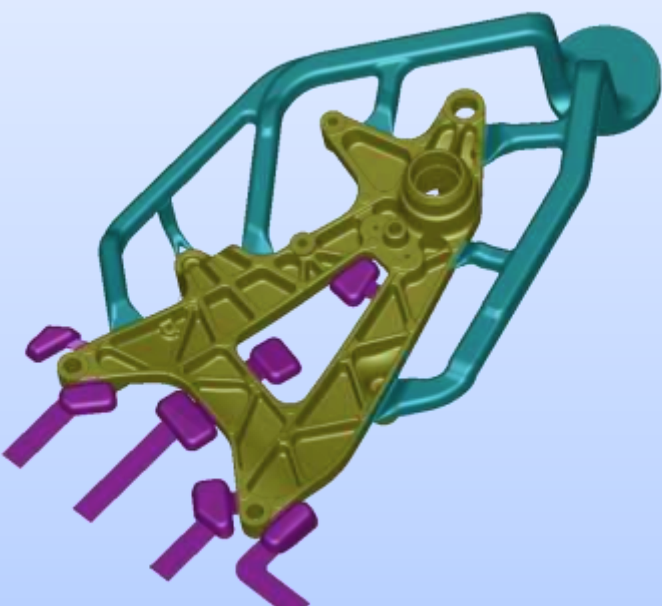
Apply Design from Wizard, runner section areas are copied from the design sheet.



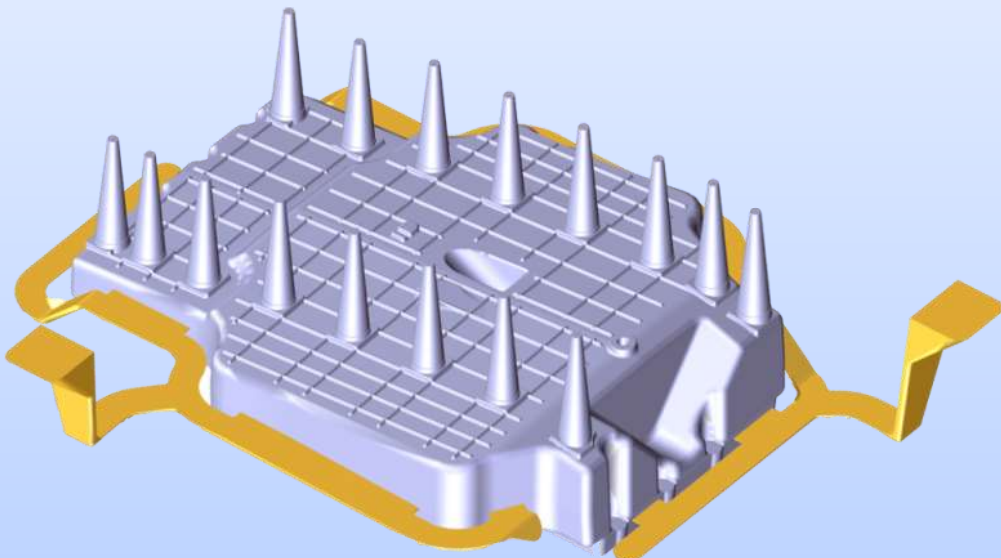
Runners, in-gates and sprue are created with design sheet values in 3D in a single click. Adjust, if required.



Gating system of engine block



Gating system of motorcycle part



Gating system of permanent mould casting

CAST-DESIGNER provides an unique method named ‘Smart Riser’ to design the riser for gravity casting process.

- Generate the riser design model, to display the EMDI contour in the design space

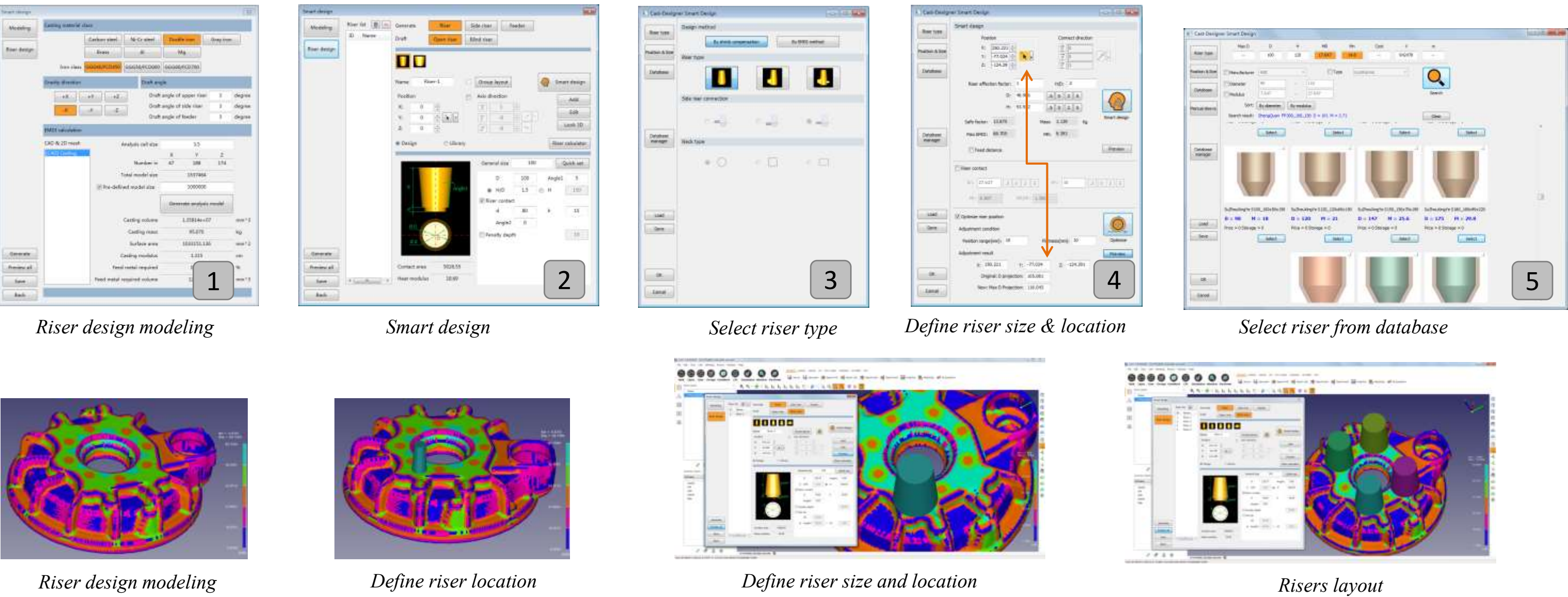
➤ Select the riser type and general parameters

➤ Click ‘Smart design’ to design the riser size and the best location.
- Predict the riser size by

 - ✓ EMDI
 - ✓ Part geometry
 - ✓ Alloy
 - ✓ Riser type
 - ✓ Guide by safe factor
 - ✓ Similar method for chill design
- Predict the best riser location

 - ✓ Part geometry
 - ✓ Alloy affection range
 - ✓ Update the location immediately
 - ✓ Riser layout design (line, cycle, array etc.)
 - ✓ Conformal chill design
- Select riser from database

 - ✓ As the designed data, such as diameter, thermal modulus to select riser from database
 - ✓ Support user’s riser
 - ✓ Support any shape of riser
 - ✓ Support any type of riser.
 - ✓ Flexible search function.



QUICKCAST TO EVALUATE CASTING SYSTEM

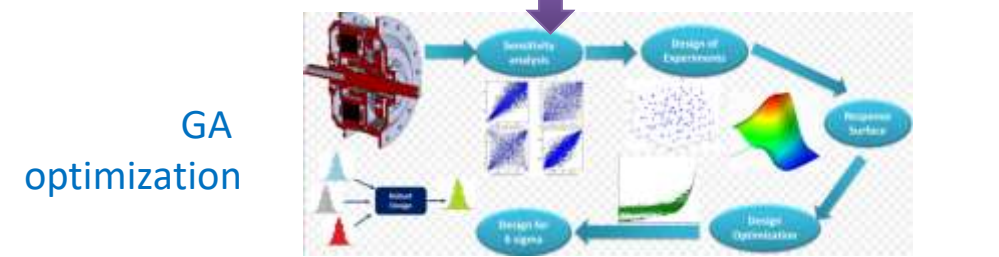
QuikCAST is a special technology to predict the metal flow in an express way to help the gating system design (Cast Zone).

- ✓ Geometric base calculation and very useful for inner gate design (size and distribution)
- ✓ Very fast (a few seconds) and flexible parameters
- ✓ Good result while compared with the CFD solver
- ✓ Support almost casting process: HPDC/LPDC/ Gravity (3 modes) / Disa casting (vertical)/ thixo-casting, lose foam casting, user defined control parameters.
- ✓ Very easy to use and good accuracy.

QuickCAST Optimization

Run & Manual opt		Auto Optimization		Start optimization					
ID	Name	Ingate S	Flow Volume	V/S	d(V/S)%	OPT	Adj_S (%)	Result S	
1	R1	107.476	385.58	3.587	2.661	<input checked="" type="checkbox"/>	3	110.701	
2	R2	107.476	385.573	3.587	2.664	<input checked="" type="checkbox"/>	3	110.701	
3	R3	107.476	377.92	3.516	0.626	<input type="checkbox"/>	0	107.476	
4	R4	107.476	377.906	3.516	0.623	<input type="checkbox"/>	0	107.476	
5	R5	107.476	350.87	3.264	-6.575	<input checked="" type="checkbox"/>	-6	101.028	
		537.384	1877.83	3.49439					537.384

Run & Manual opt		Auto Optimization		1 st optimization result						
	ID	Name	Ingate S	Flow Volume	V/S	d(V/S)%	OPT	Adj_S (%)	Result S	
1	R1	110.701	397.276	3.588	2.699	<input checked="" type="checkbox"/>	0	110.701		
2	R2	110.701	397.29	3.588	2.703	<input checked="" type="checkbox"/>	0	110.701		
3	R3	107.476	377.258	3.51	0.45	<input checked="" type="checkbox"/>	0	107.476		
4	R4	107.476	377.231	3.509	0.443	<input checked="" type="checkbox"/>	0	107.476		
5	R5	101.028	328.773	3.254	-6.871	<input checked="" type="checkbox"/>	0	101.028		
		537.384	1877.83	3.49439					537.384	



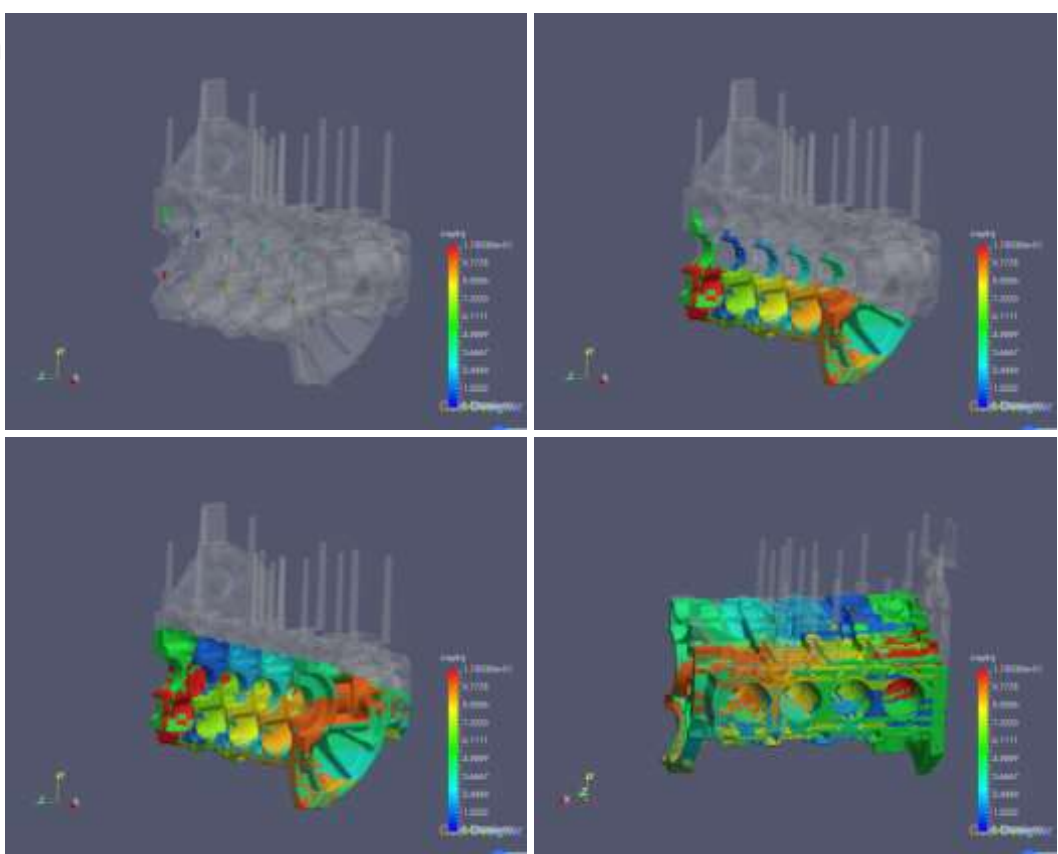
Run & Manual opt		Auto Optimization		The last optimization						
ID	Name	Ingate S	Flow Volume	V/S	d(V/S)%	OPT	Adj_S (%)	Result S		
1	R1	124.381	434.261	3.491	0.571	<input type="checkbox"/>	0	124.381		
2	R2	131.158	457.996	3.491	0.565	<input type="checkbox"/>	0	131.158		
3	R3	137.432	479.669	3.49	0.538	<input type="checkbox"/>	0	137.432		
4	R4	73.975	252.995	3.419	-1.484	<input type="checkbox"/>	0	73.975		
5	R5	73.975	253.008	3.42	-1.479	<input type="checkbox"/>	0	73.975		
		540.924	1877.83	3.47152						

Automatic optimization of QuickCAST design

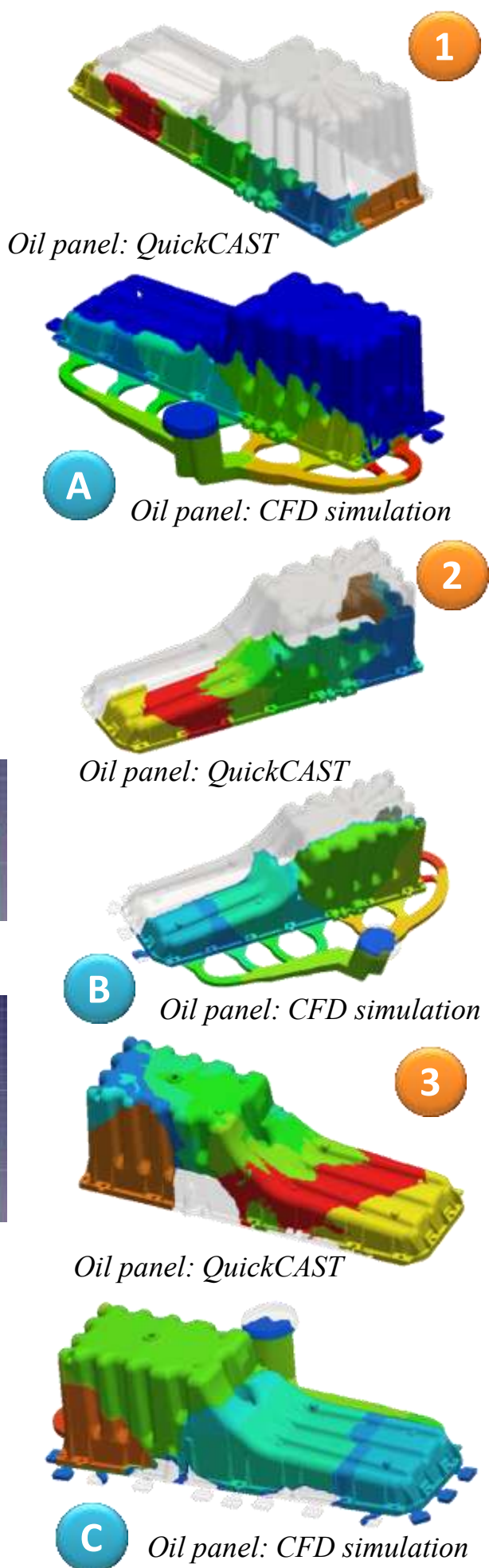
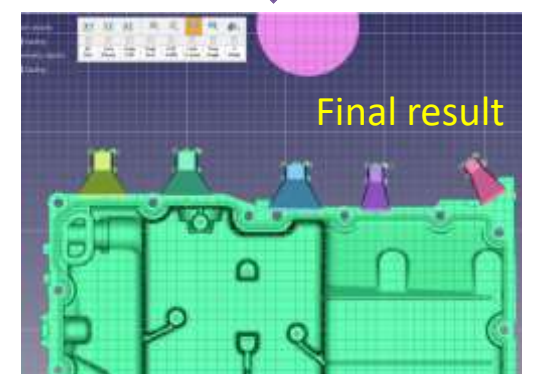
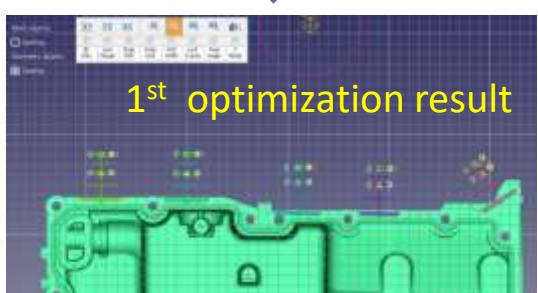
- The QuickCAST can make optimization in manually or automatic in the GA technology.
- No need to open post-process each time, the system can collect result automatically
- Give clear guide line for inner gate adjustment
- Multi design plans and fully automatic (Auto optimization)
- Balance the flow length as criteria with rich analysis result: gate color and flow length, filling time etc.

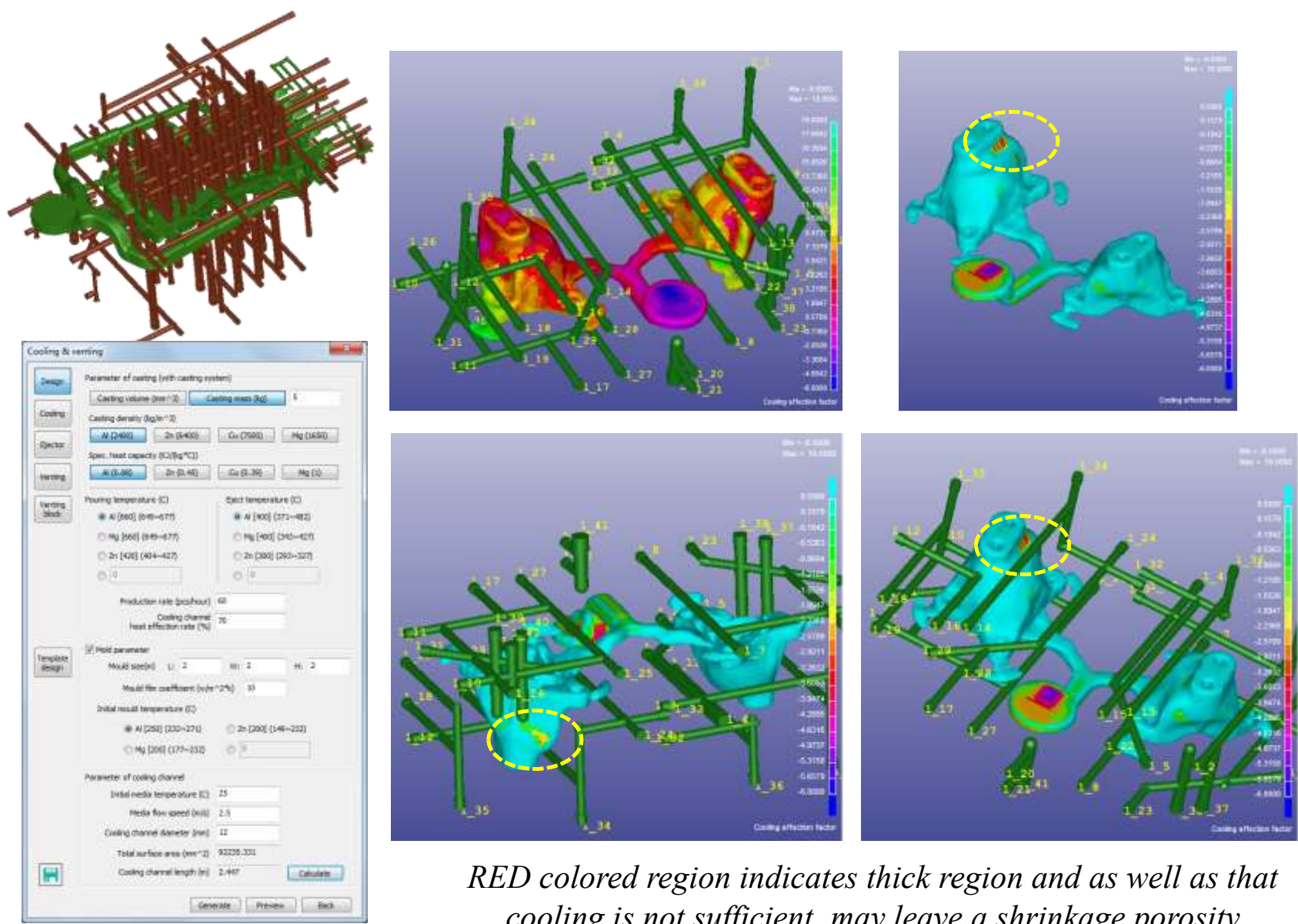
Gate runner define										
Active	ID	Name	S_end	V	D	S_time	Vel			
<input checked="" type="checkbox"/>	1	R1	124.381	49.752	2.5	0	40			
<input checked="" type="checkbox"/>	2	R2	131.158	52.463	2.5	0	40			
<input checked="" type="checkbox"/>	3	R3	137.432	54.973	2.5	0	40			
<input checked="" type="checkbox"/>	4	R4	73.975	29.59	2.5	0	40			
<input checked="" type="checkbox"/>	5	R5	73.975	29.59	2.5	0	40			

Final result



QuickCAST analysis for engine block (Gravity casting)





Cooling system design wizard

Cooling system design is another very important task in mould design. It will affect the solidification process and final result directly, such as the shrinkage porosity, stress and distortion after casting. Also, the die life time and production rate are related to the cooling system directly.

The cooling system designer is a CAD base module to help cooling channel generation in **CAST-DESIGNER**. It provides a very flexible way to generate any complex cooling system, like cooling channel and heat channel.

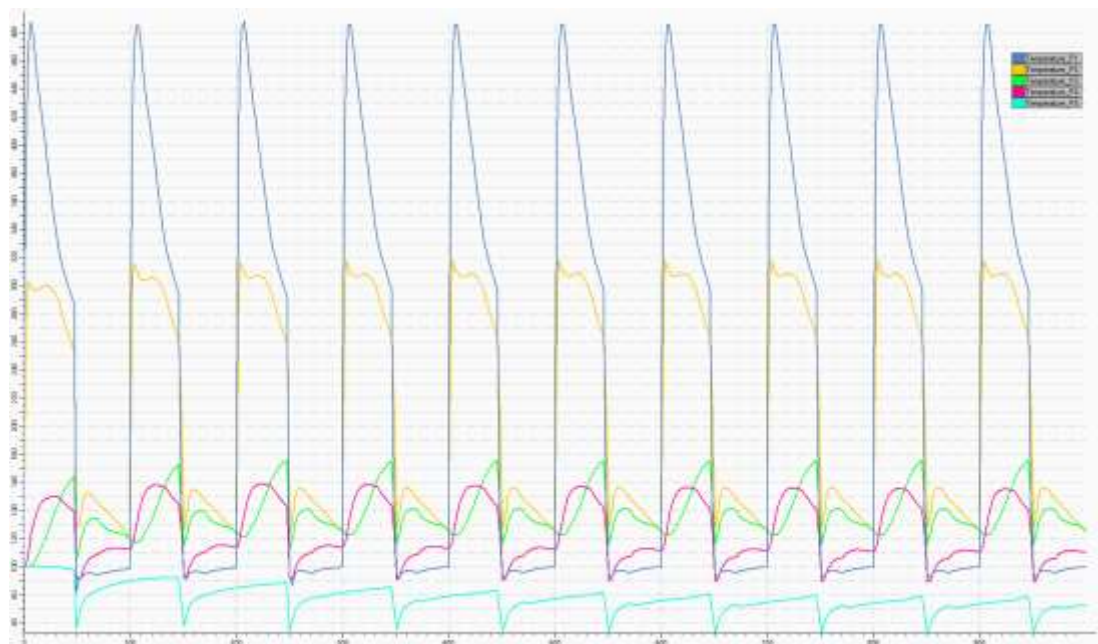
In stead of numerical simulation, **CAST-DESIGNER** introduces an online cooling system analysis method to help designer check the cooling system design at the very early stage, it is fully integrated to the cooling system design interface and the user can get result within 3 to 5 minutes.

CAST-DESIGNER brings a new concept to cooling system design and analysis, full parametric design for cooling system, following a fast cooling system analysis to check the design performance.

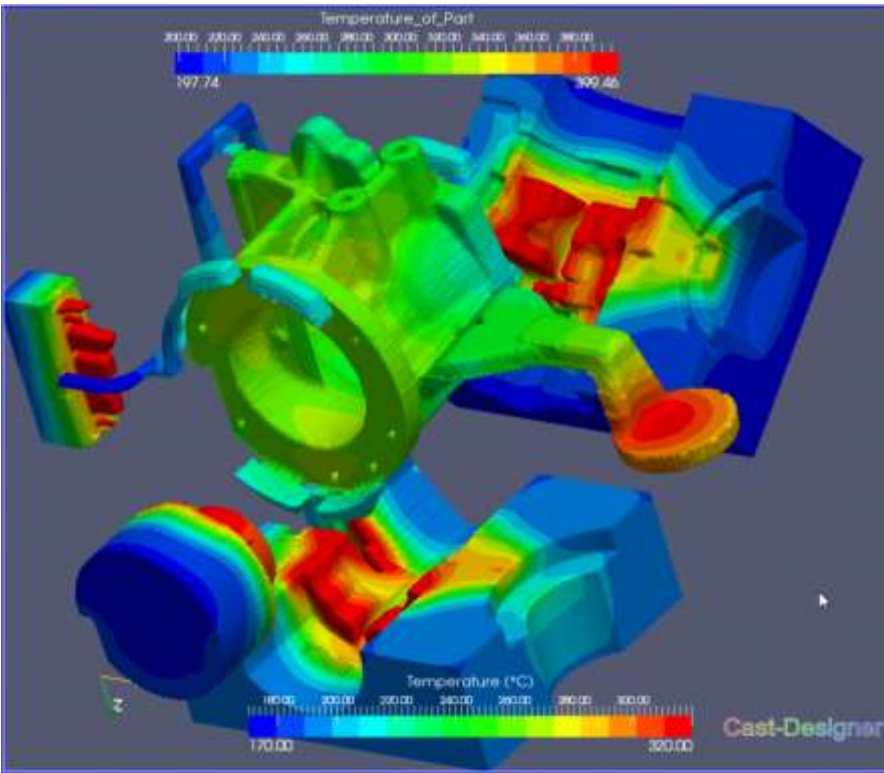
The die casting process module provides the capability for mould cycling in permanent die.

Definition of all important parameters influencing heat flow and the thermal balance of mould.
Comprehensive definition of the entire cycle process

- Ejection time (controlled by time or casting temperatures)
- Die opening sequence (as function of time)
- Delay time (simulating effect of cycle interruptions on the thermal balance)
- Die closing sequence (as function of time and temperature)
- Lead time until beginning of the next cycle
- Variations in the lead time can be simulated
- Three spraying modes could be selected



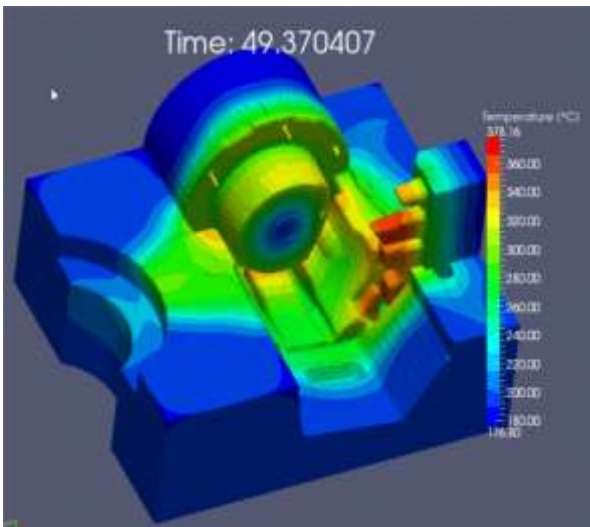
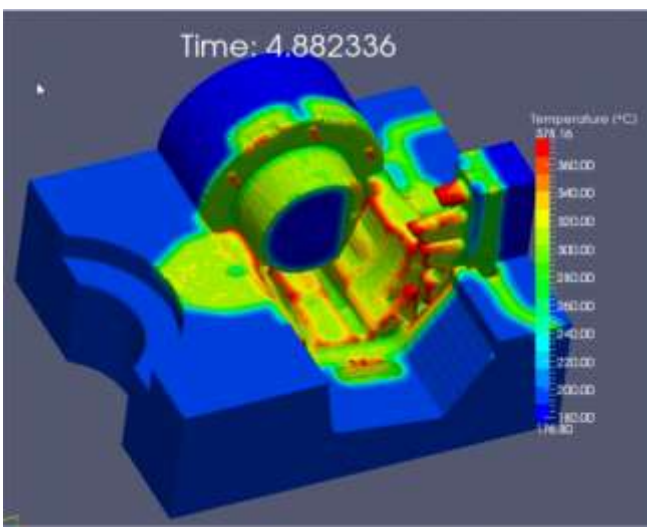
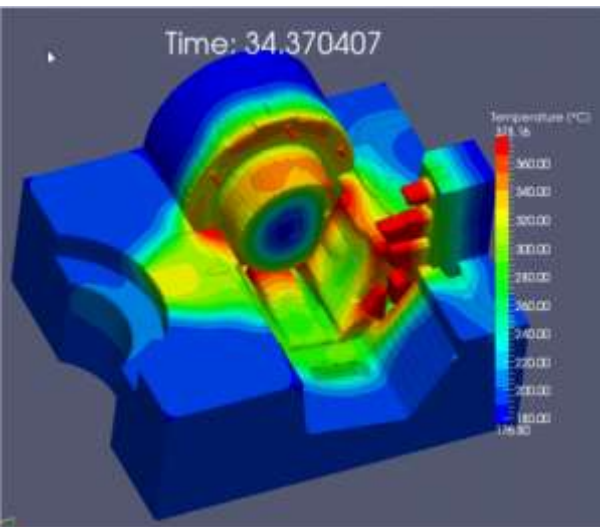
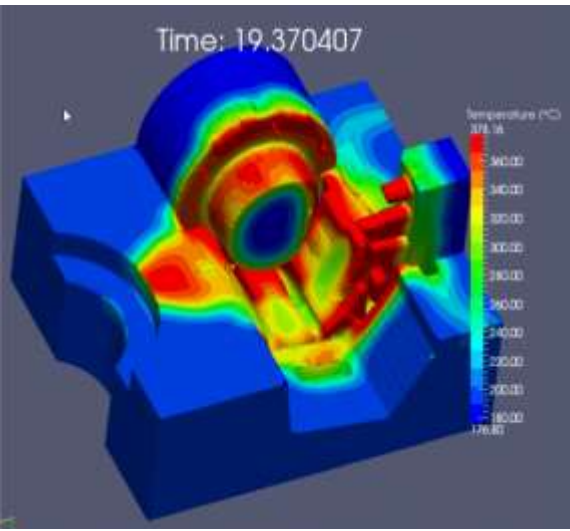
Cycling simulation to achieve the thermal balance



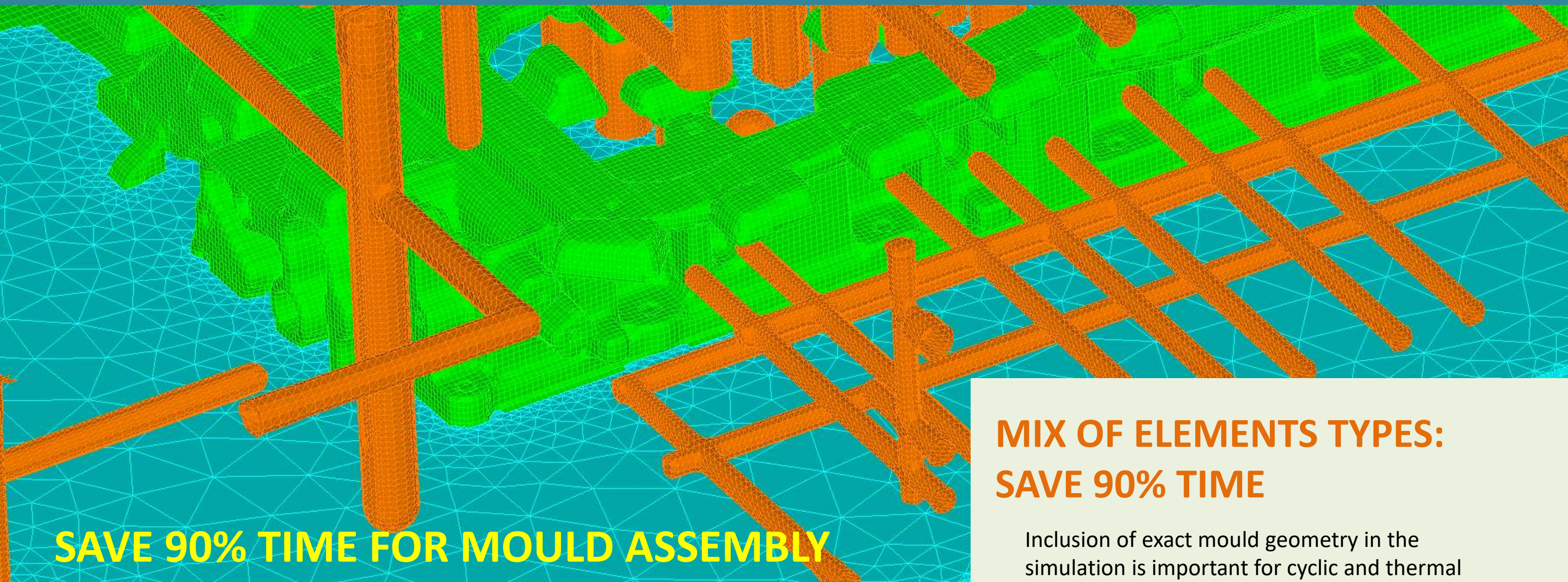
Casting and mould temperature of the casting process

DIE COOLING & TEMPERING

- Complete consideration of die cooling and tempering system
- Individual control of each cooling or tempering channel
- Channel control can be dependent on time or temperatures



Temperature distribution on the die surface during the complete casting cycle



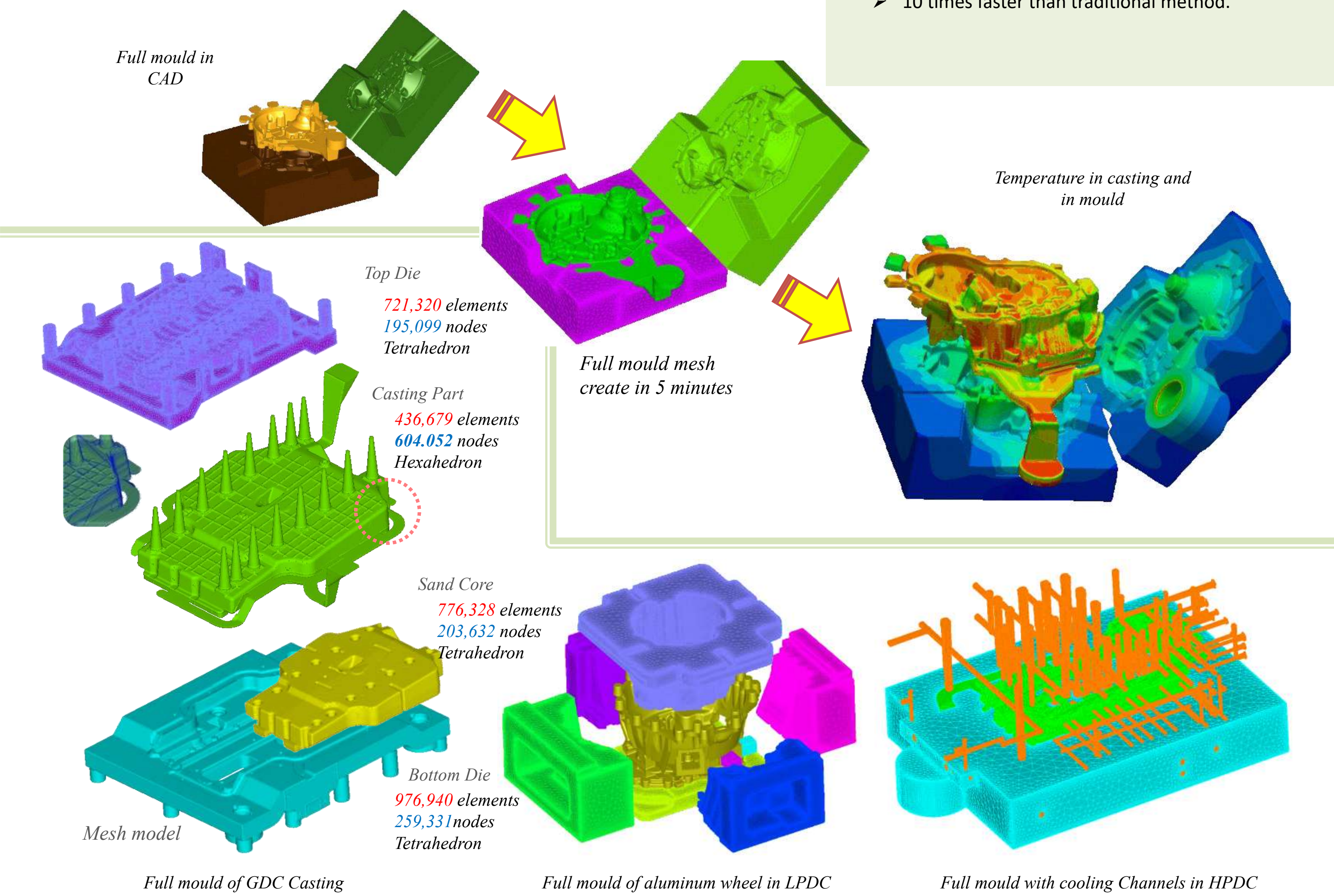
BEST-IN-CLASS MESHING TECHNOLOGY

CAST-DESIGNER mould assembly can build complex meshes from a full 3D CAD assembly that includes casting and all major components of the die for HPDC, GDC and LPDC. The full mould assembly meshing is fully automatic and done in one click, it saves more than 90% of manual work and meshing time. Innovative technologies, such as the re-mesh technology of different contact interface, coarse mesh technology, mesh mapping technology and automatic driving batch mesh technology. Parallel meshing is used in the whole process.

MIX OF ELEMENTS TYPES:
SAVE 90% TIME

Inclusion of exact mould geometry in the simulation is important for cyclic and thermal balance of the mould.

- Hexagon mesh for casting parts: good for flow analysis
- Tetrahedron mesh for mould parts: good for heat transfer and mechanical stress analysis and it is robust and gives faster results. It can change its size ratio drastically.
- The challenge is node-to-node connectivity between different mesh types, and **CAST-DESIGNER** handle it automatically and effectively.
- 10 times faster than traditional method.



The advance spraying model of Cast-Designer lets users to model all facets of die preparation, taking into account the influence of the shape of the mold surface and the position and movement of the spray nozzles. It can accurately predict the exact temperature distribution on the die surface with reliable and realistic input parameters for thermal die cycling simulations.

This can help the metal casting engineers to better design and evaluate the internal cooling structure of the die, and the spray cooling parameters.

For every spray surface element, the HTC is computed by multiplying the base HTC by dependence factors,

$$HTC = HTC_0(T) * F_d(d) * F_a(\alpha) * F_c(\Theta)$$

- $F_d(d)$ is the distance d dependent factor function.
- $F_a(\alpha)$ is the spray angle α dependent factor function.
- $F_c(\Theta)$ is the die face normal and the spray direction Θ dependent

Nozzle design & online validate

CAST-DESIGNER provides rich tools to design the spraying nozzle and make the layout, then validate the design online.

- ✓ Design the head plate at first to define the reference.
- ✓ The ParaCAD design environment could design the spray nozzle and make the layout easily.
- ✓ The special designed cone includes all the parameters of spraying nozzle. It could be dragged and placed to anywhere in the ParaCAD environment.
- ✓ The casting part or mould could be used as background to define the nozzle position.
- ✓ Designed result could save to CSV file and imported by advance spraying of CPI setup.

Mould opening

- Define the mould opening distance and opening direction.
- Consider different mould types (fix mould or moveable mould) and different movement. For example, slider attached to different mould.
- Support multi-objects.
- Define general lead time of each mould spray.



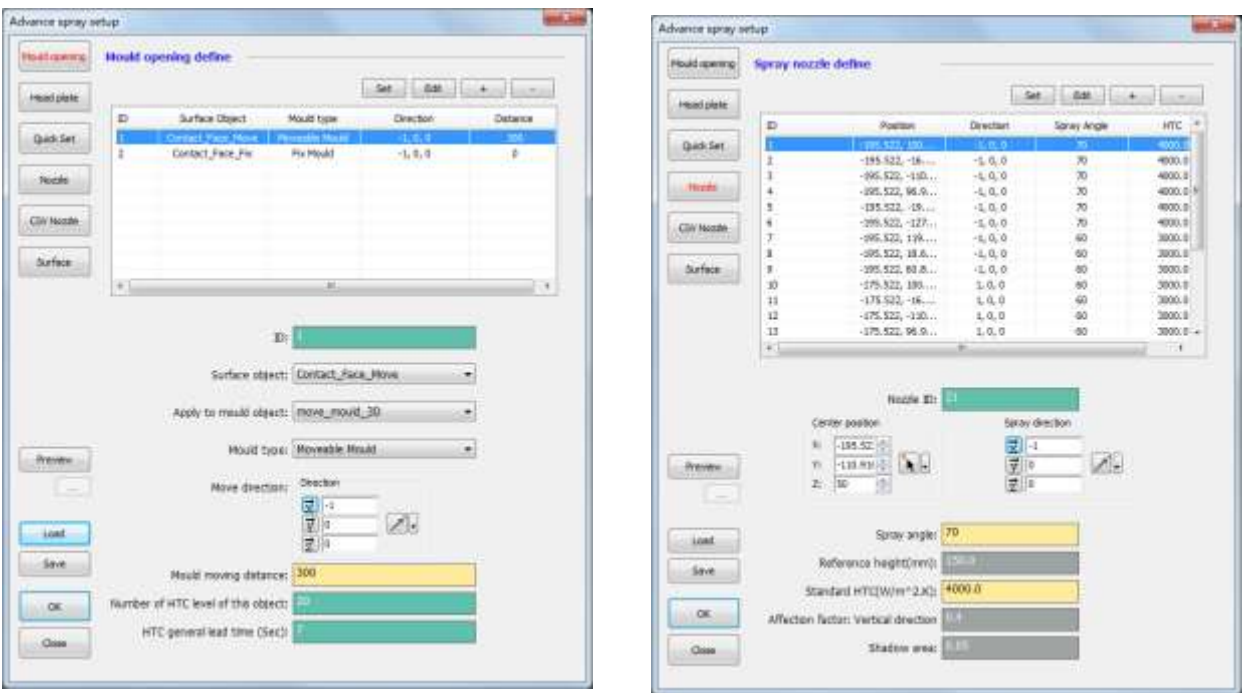
Head plate

- Define the head plate of the spraying. It also could be controlled by robot arm in NC program.
- Head plate information:
 - Working plane
 - Size of the head plate
- Head plate can move to different position in different lead time.
- All parameters could be defined by user in the interface.

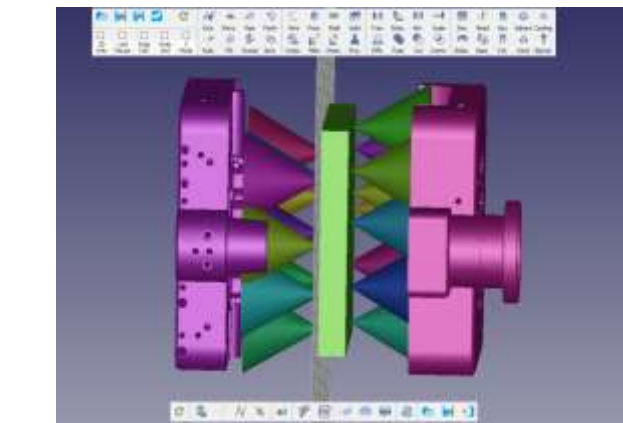


Nozzle define

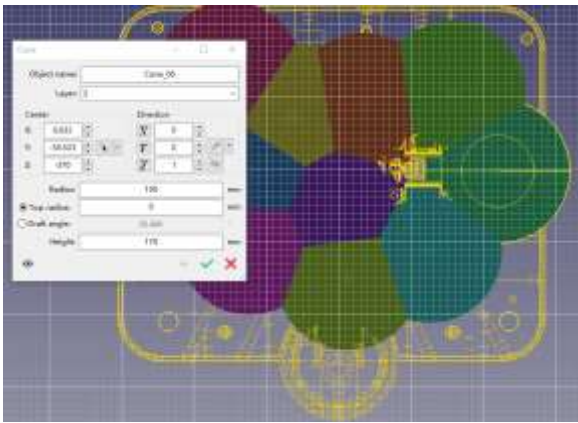
- Define the nozzle for spraying. Four methods provided in the system.
 - Face type: Set the whole face as nozzle.
 - Quick Set: set multi-nozzles in array.
 - Nozzle: define nozzle one by one.
 - CSV nozzle: read nozzle data from external CSV file.
- The reference height and standard HTC could be defined by user.
- The affection factor in surface normal angle and shadow area could be defined by user also.



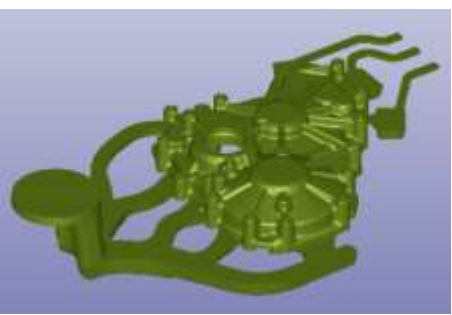
Advance spraying user interface (Mould opening & Nozzle define)



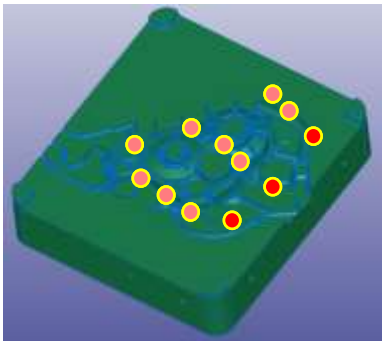
Head plate design



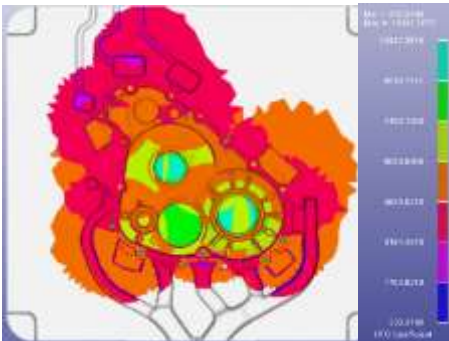
Nozzle design & layout



Casting part

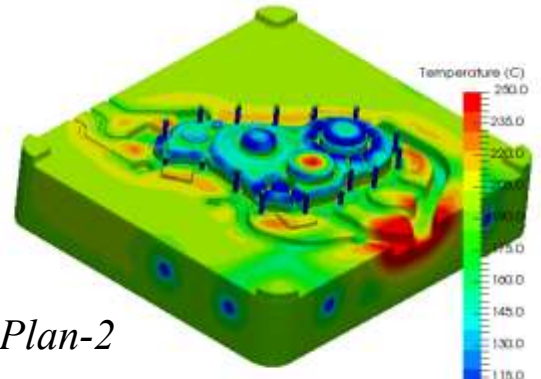
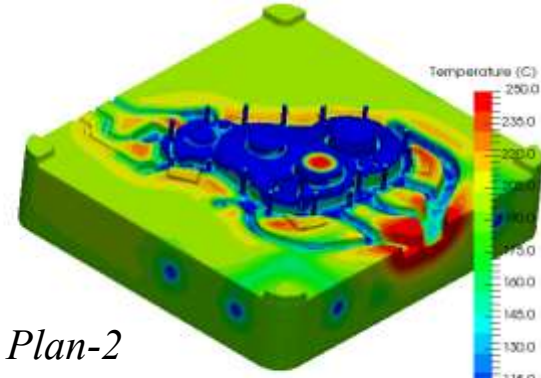
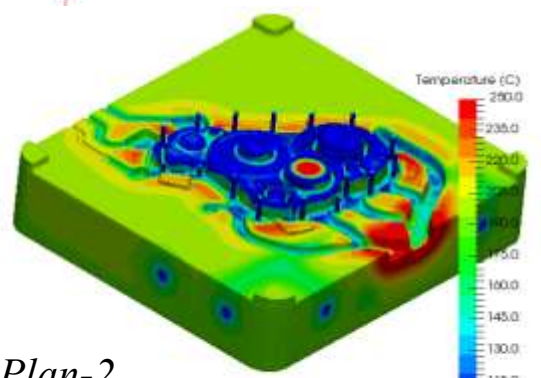
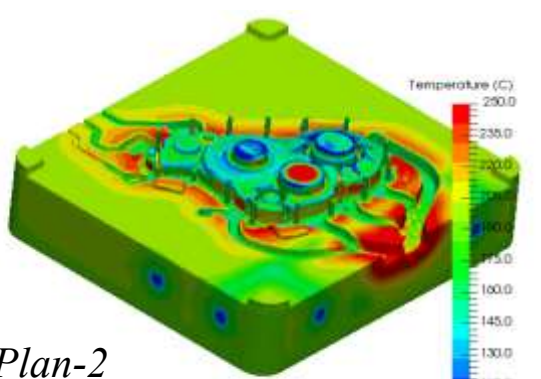
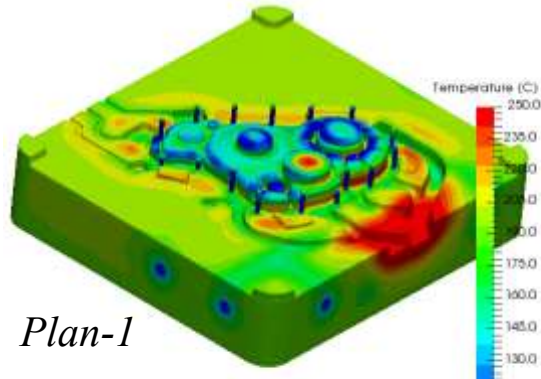
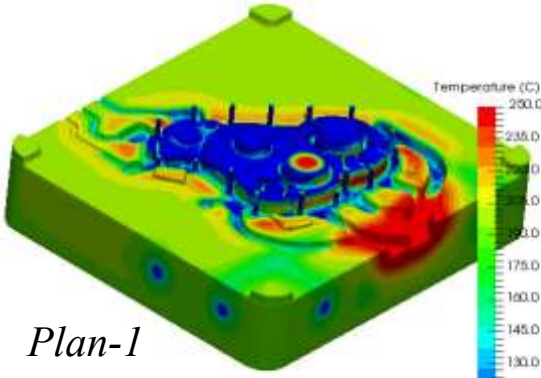
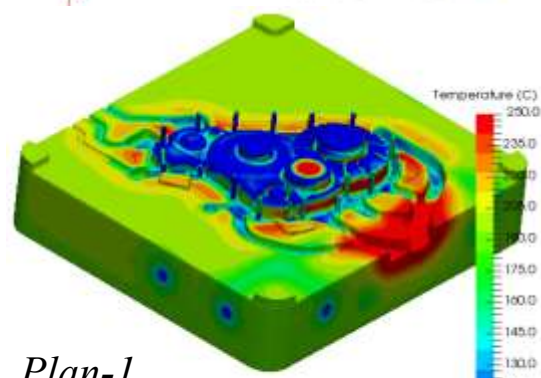
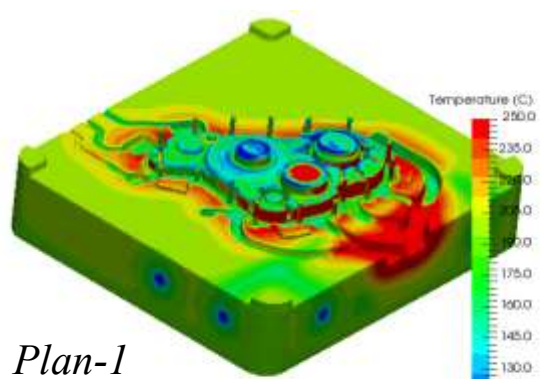


Nozzle layout



Online validation

Simulation result



There are two design plans for advance spraying. One is no nozzles on the main runner region and another one was three nozzles on the main runner region.

The lead time of spraying was 5 seconds only and the whole simulation was 10 seconds.

The result of 4.51 second shows the different of temperature distribution of the vertical region and this affection is continue until the end of the simulation.

The exact industrial conditions in die casting can be simulated in **CAST-DESIGNER** with cycle time, die cooling, die heating etc. **CAST-DESIGNER** Production Optimizer automatically adjusts the die opening, die spray, cooling or heating channels and individual production cycle timings for a reasonable thermal balance of the mould and optimizes production cycle time for best productivity.

Mould Cycling and Automatic Thermal Balance

DIE SPARY, COOLING & HEATING

- Complete consideration of die cooling and heating system
- Individual control of each cooling or heating channel
- Different die-spray and die-coatings can be considered

PRODUCTION OPTIMIZATION

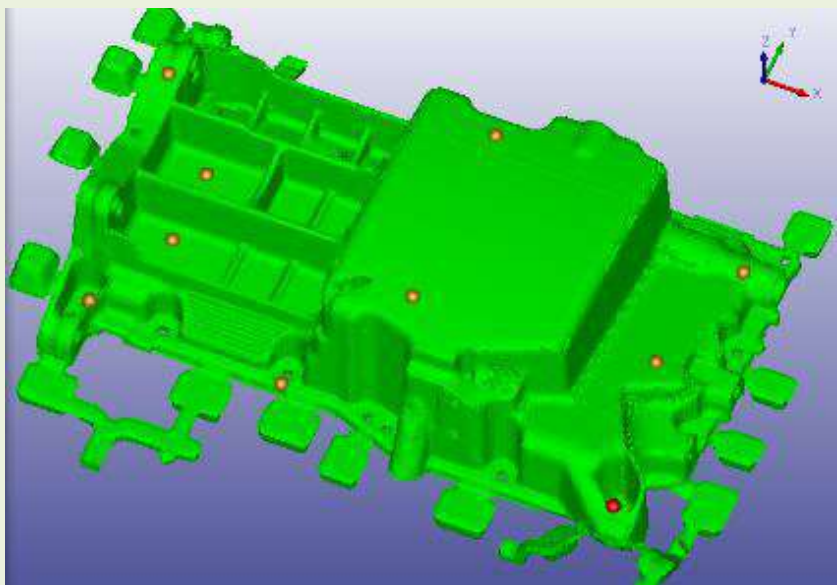
- **CAST-DESIGNER** Production Optimizer automatically adjusts the cooling/heating channels and individual production cycle timings, to maintain a reasonable mould temperature to avoid cold-shut or die soldering conditions.
- Achieve best productivity and cost rate, as well as the product quality.
- Achieve better die-life, and reduced die maintenance cost.

PRODUCTION COST CALCULATION

- Casting Production can make a quick calculation of the production cost based on the optimized cycling. It could be used for the quotation purpose, price estimation or for the production phase cost control.

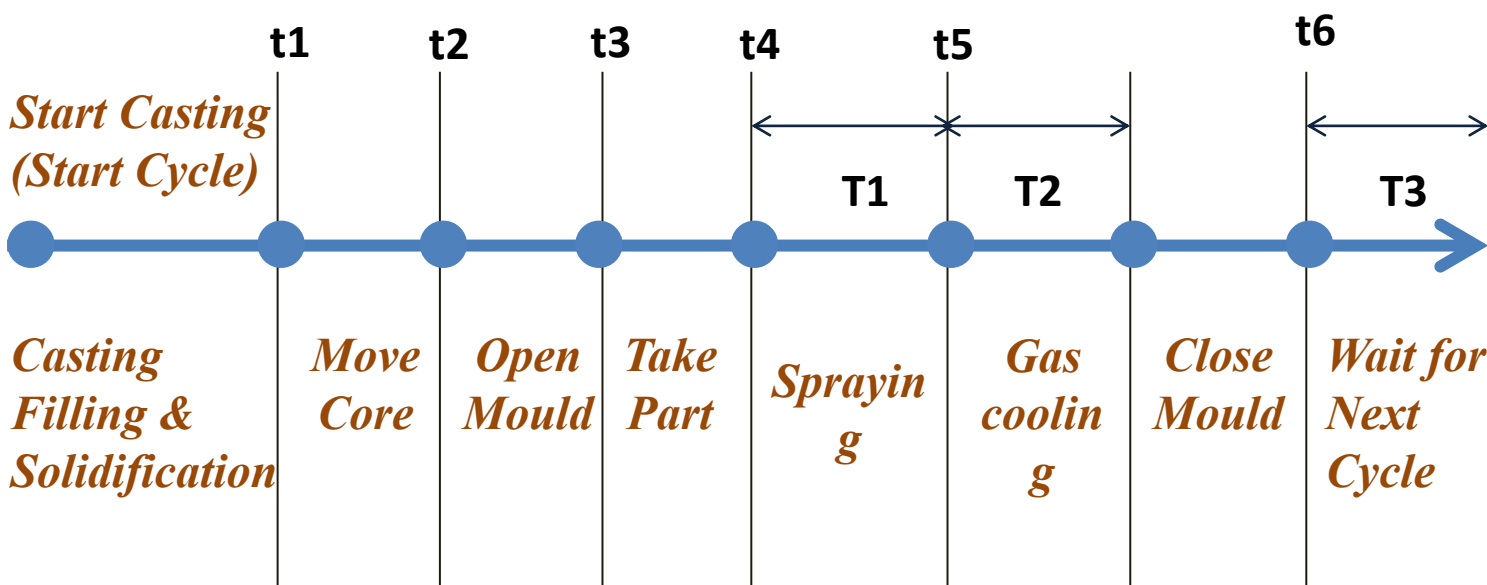
SAMPLE OPTIMIZATION RESULT

- Use Sensor(s) on the casting part or on the mould to check the conditions to optimize.
- Sensor can be attached to the cooling channel or heater to optimize it.
- User defined weight factor to different sensors.
- In 3 iterations, cycling time is optimized from 86 sec to 66 sec.

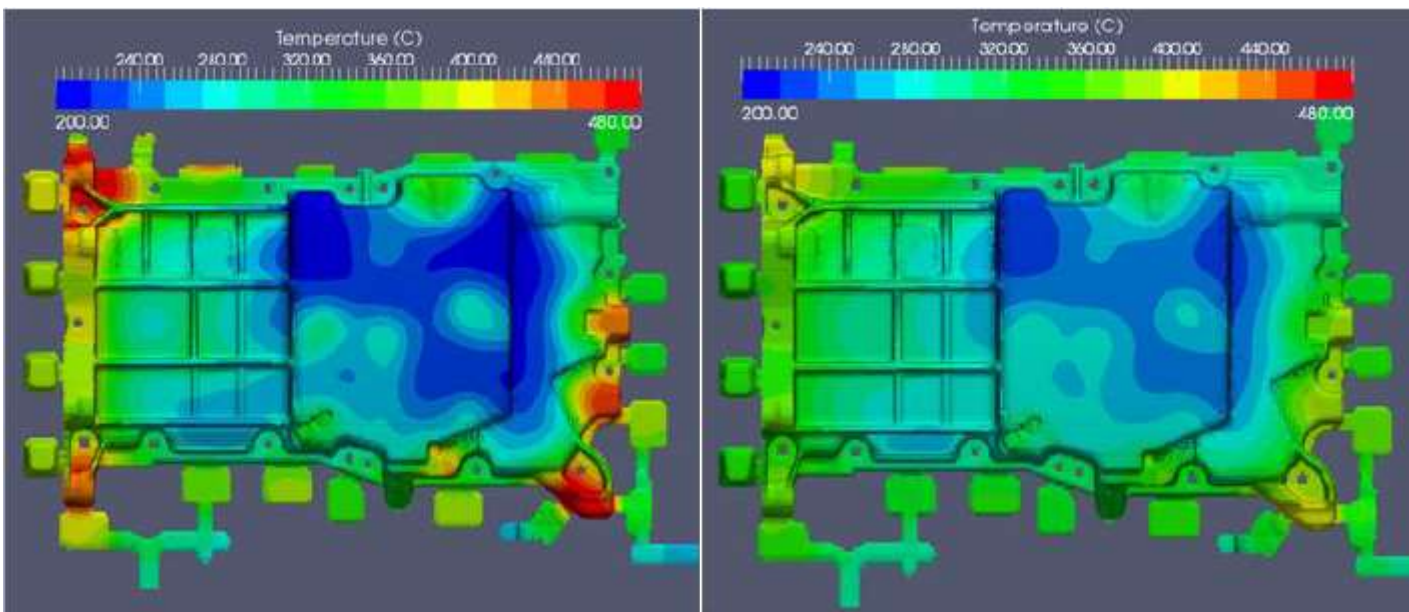


Operation & Time in Sec	Original	Opt iter-1	Opt iter-2
Waiting next cycle	26	9	8.1
Die Closing	27	27	27
Part Ejection	14	14	14
Die Opening	19	16	17
Total in Seconds	86	66	66.1

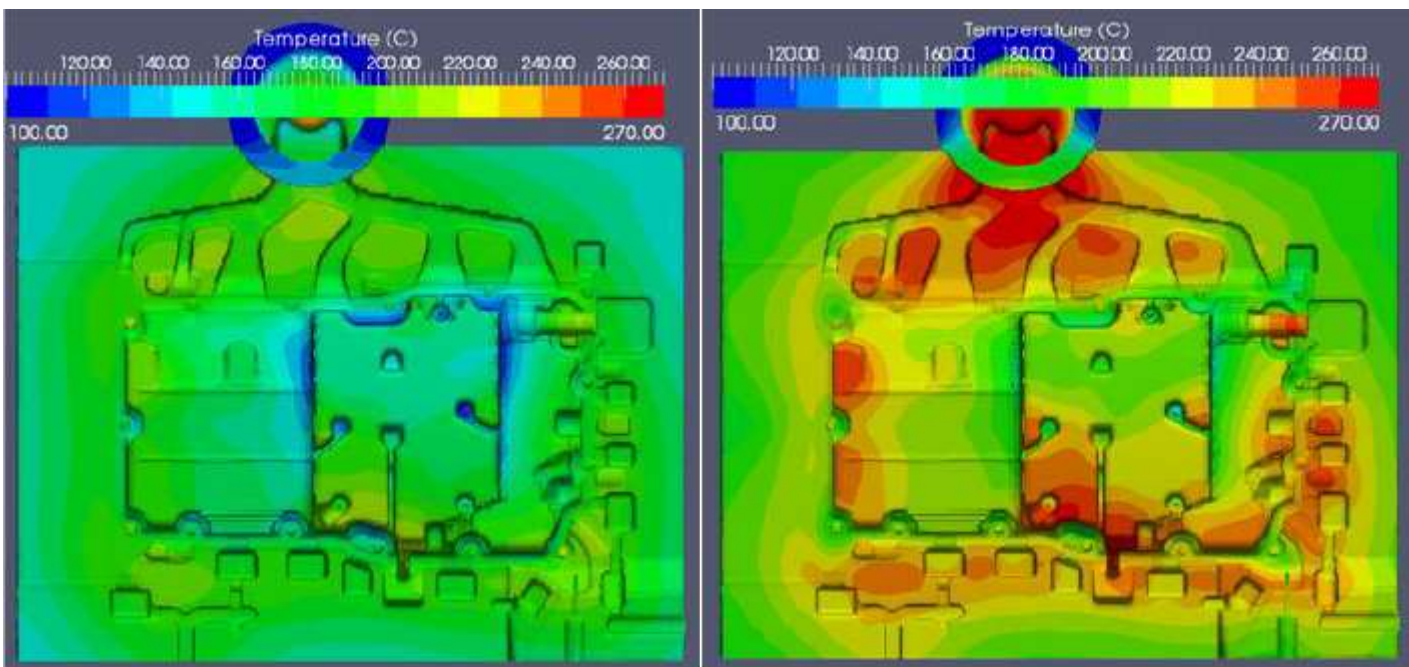
CYCLE TIME DEFINITION



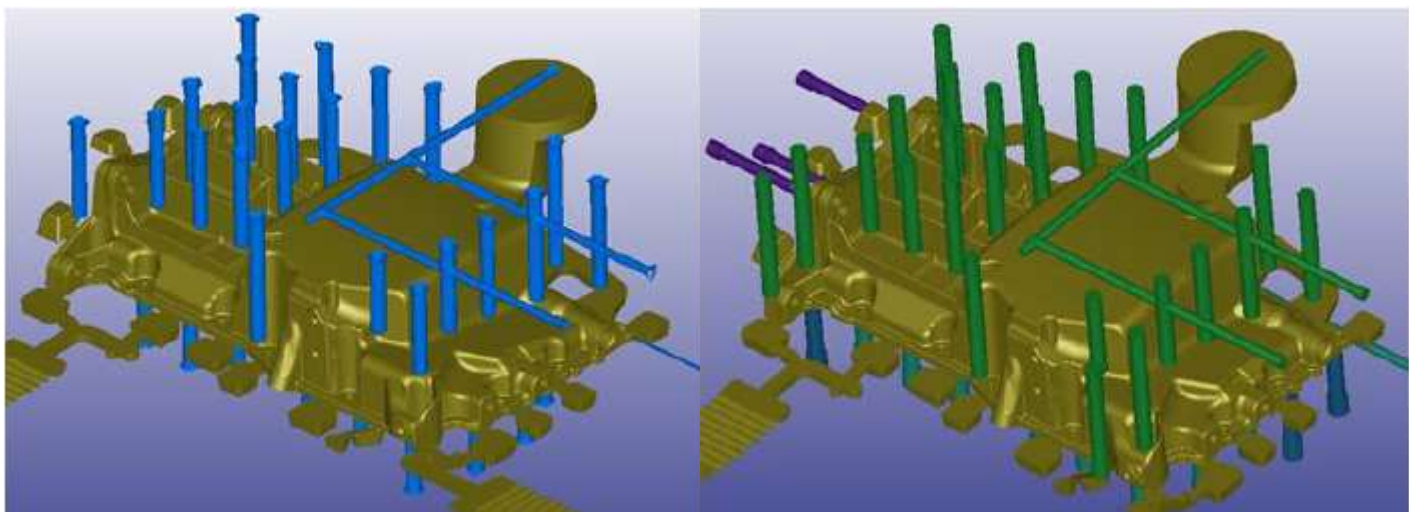
Definition of all important parameters influencing flow temperature and the thermal balance of mould.



Before: Casting Temperature with Hot Spots with 480 °C can cause Mould Stick. After: Casting Temperature is now more balanced around 400 °C can avoid Mould Stick.



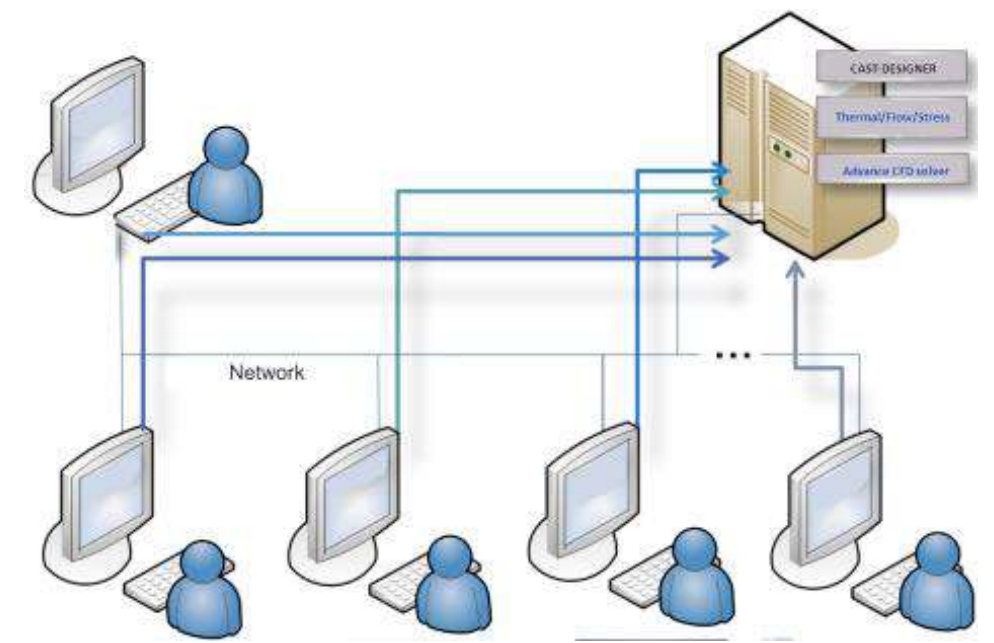
Before: Mould Temperature is below 120 °C and can cause Cold shut. After: Mould Temperature is now 260 °C and more balanced and can avoid Cold shut.



Before: Original Cooling Channel Design After: Modified Cooling Channel Design

Cast-Designer optimizer can execute multi-criteria non-linear optimization based on Genetic Algorithm as known in Artificial Intelligence.

- **Multiple Criteria Targets:** All physical problems could be optimized, including the flow, thermal, stress, warpage, microstructure, material properties etc. For Example: Single or multiple targets of the simulation, what the foundry engineer is trying to achieve like to maximize the yield, minimize shrinkage or the minimize gas entrapment and balance the flow during the filling process.
- **Multiple Design or Process Variable:** Design elements that are allowed to vary, could be the Parametric CAD Geometries like runner dimensions, inner gate locations or riser diameter, even original casting part, or process parameters, like pouring temperature, velocity, or the HTC.
- **Genetic Algorithm** in **CAST-DESIGNER** Optimizer, checks the results of each optimization iteration like shrinkage porosity volume and intelligently sets the new value for the design variables like size and location for the riser. Such iterations are continued until the targets are achieved.
- **Complex user formulas** are supported.



*Cast-Designer Optimization supports **parallel automatic optimization**, this is a breakthrough technology to reduce the lead time of optimization.*

GATING OPTIMIZATION

Find the best locations and sizes for:
Gating system
Runner, Overflow
Cooling, Riser, Chill

PROCESS OPTIMIZATION

Find the best process variables like:
Pouring temperature
Die temperature
Pouring rate, Ejection time

PART OPTIMIZATION

Find the best dimensions or locations of
Part Features
For Defect-Free Castings

Minimise Porosity

Avoid Air-Entrapment

Achieve Better Filling

Improve Die-Life

Optimise Yield

Minimise Warpage

DESIGN OF EXPERIMENTS

Design of Experiment (DOE), to study a process window and its robustness so as to obtain a set of ideal parameters which provide good result inside an user defined goal.

For Example:

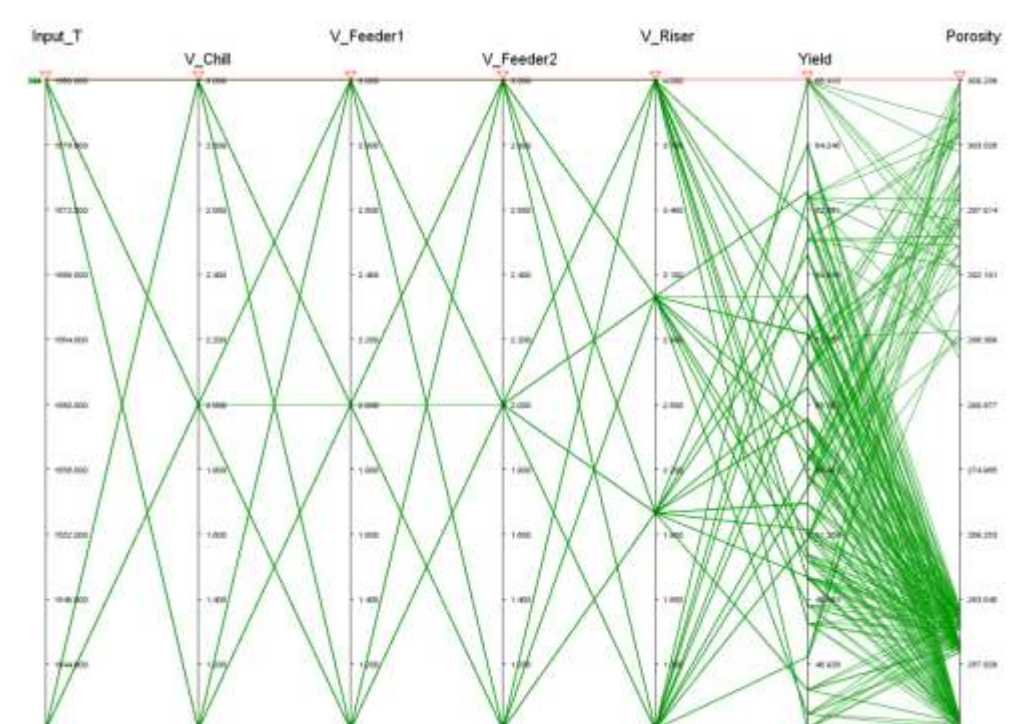
- **Yield:** To find best location and size of risers to minimize shrinkage porosity.
- **Sensitivity:** To identify the sensitivity of the influential process parameters like increasing the mould temperature vs. adding insulation sleeve.
- **Cost:** Compare costs for maintaining higher melt temperatures vs. rejection/production losses.
- **Feasibility:** Determine the optimization goals, manufacturable aspects during production, in-line with the known production constraints of a foundry

PROCESS ROBUSTNESS

Stochastic approach to check that the given process is robust.

For Example:

Vary the furnace temperature with in the known range to check that the process is robust, Find out the maximum and minimum variations allowed in the process while still obtaining the desired good quality parts.

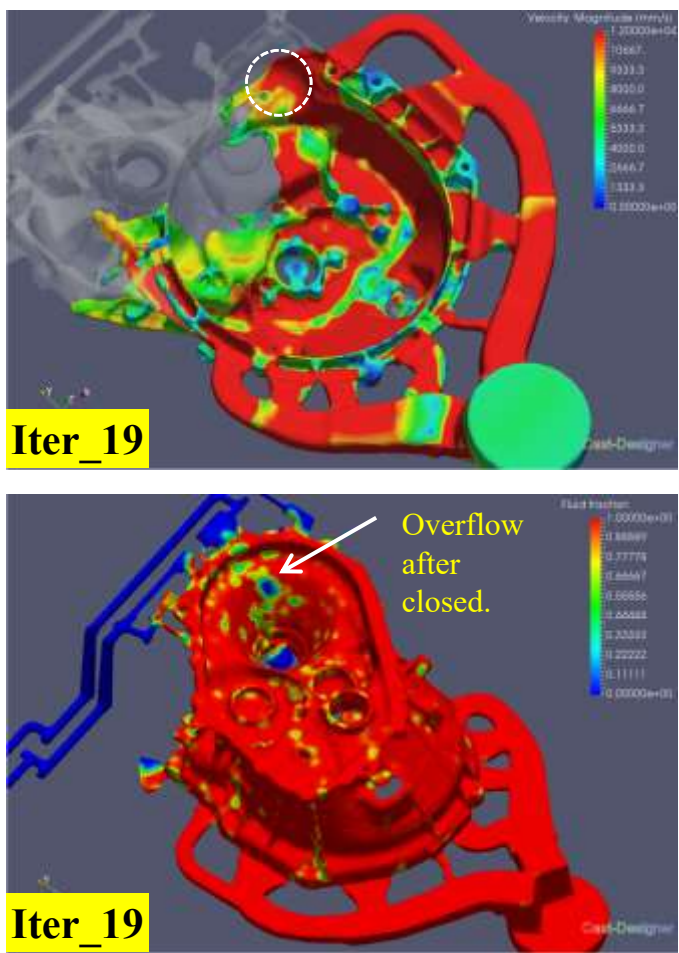
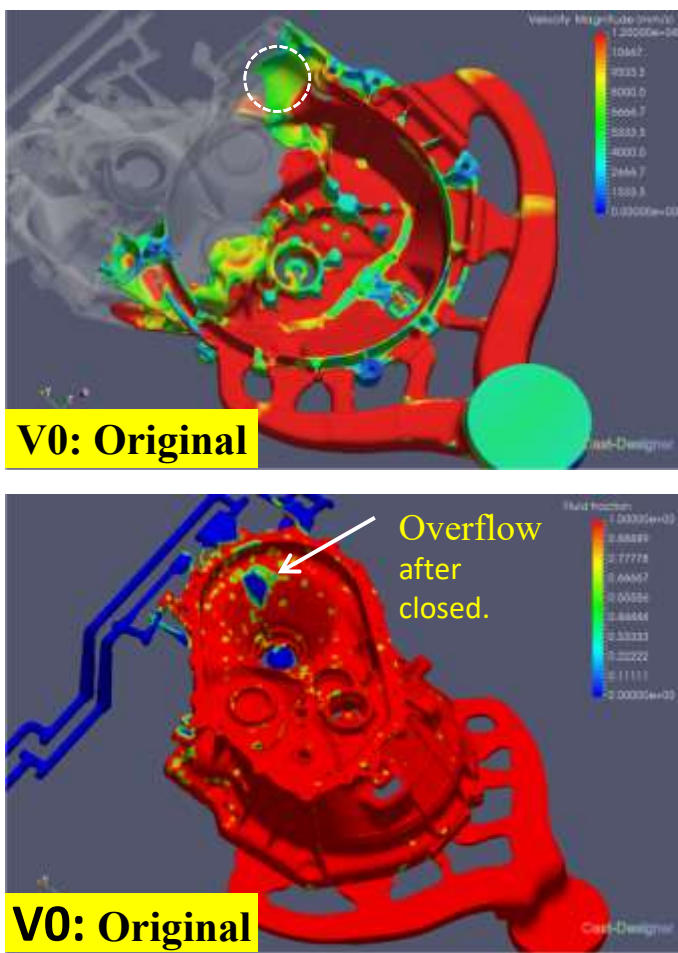


The Taguchi DOE method provides best possible combination of variations. For Example: out of 512 combinations, it is possible to get desired results by trying 16 combinations

HPDC: RUNNER OPTIMIZATION

ORIGINAL DESIGN

OPTIMIZED DESIGN



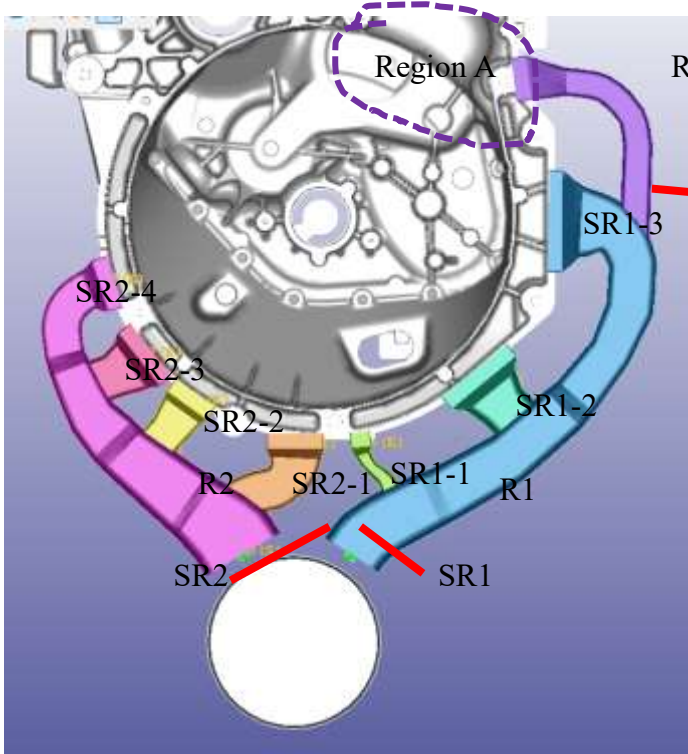
OPTIMIZATION SETUP

To have a balance flow and avoid the gas entrapment of the flow process, we set parameters to optimize the model.

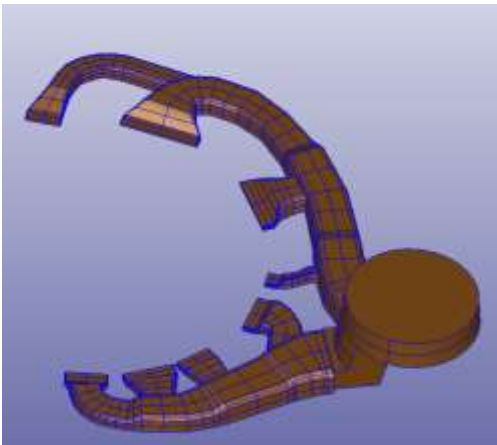
Parameters:

- K1 = SR1/SR2
- K2 = SR3/SR1

When K1 and K2 change, the section area of runner R1 and R2 also will be adjusted, and the linked sub-runner SR1-1, SR1-2, SR1-3, SR2-1, SR2-2, SR2-3, SR2-4 also will be updated. If K2 < 0.20, then the runner R3 will not be generated.

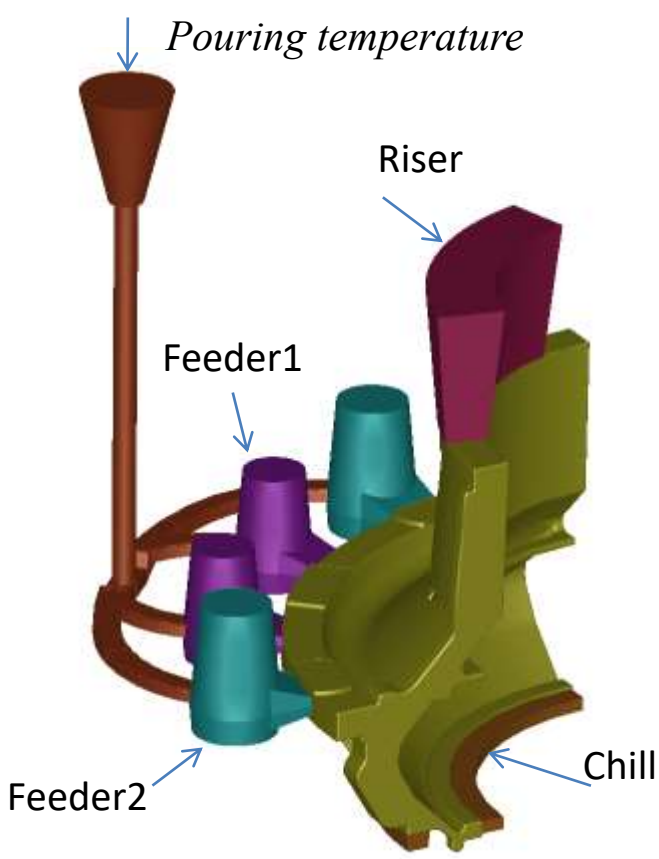


We make the optimization for K1 and K2.
K1: 0.80 ~ 1.40
K2: 0.05 ~ 0.35

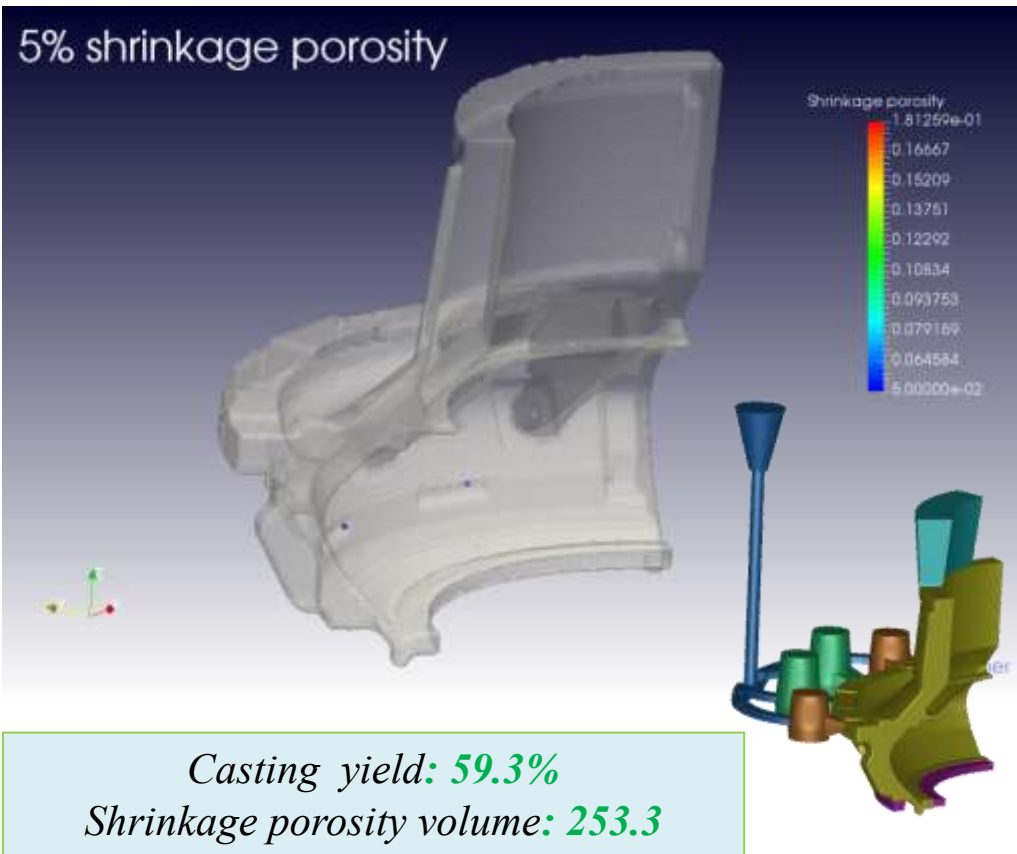


The final optimized gating.

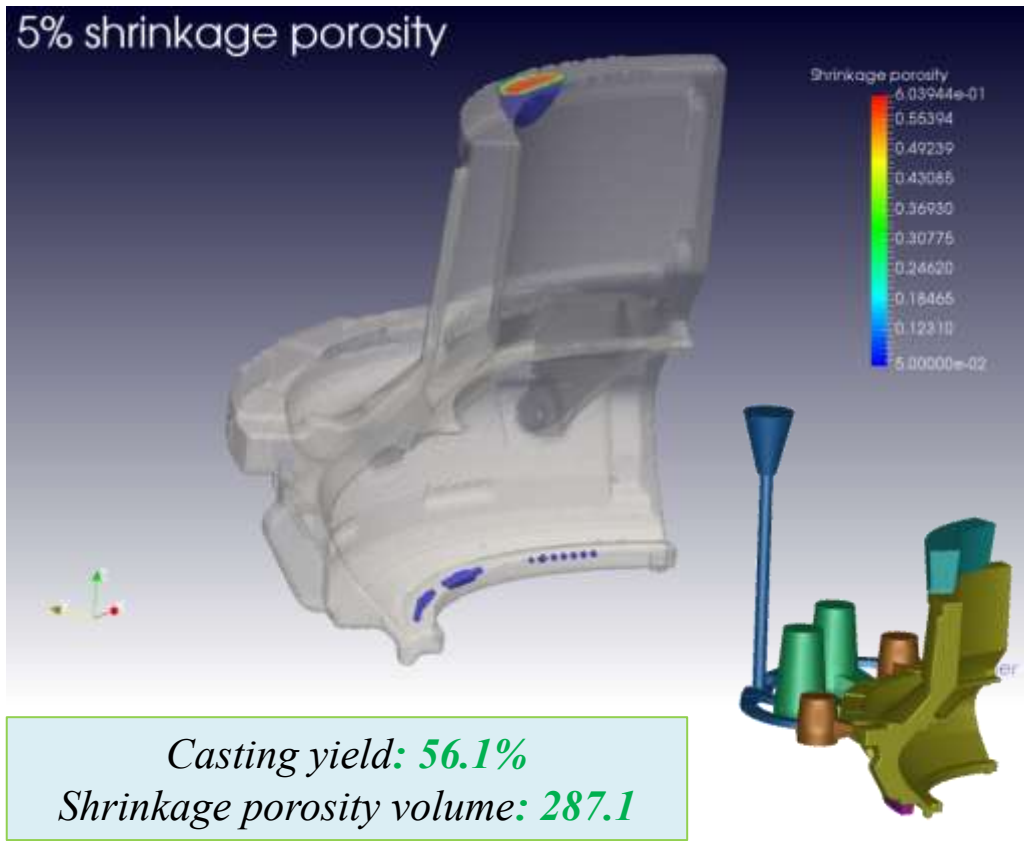
GRAVITY CASTING: RISER OPTIMIZATION



OPTIMIZED DESIGN (The best one)



OPTIMIZED DESIGN (The worst porosity)



OPTIMIZATION SETUP:

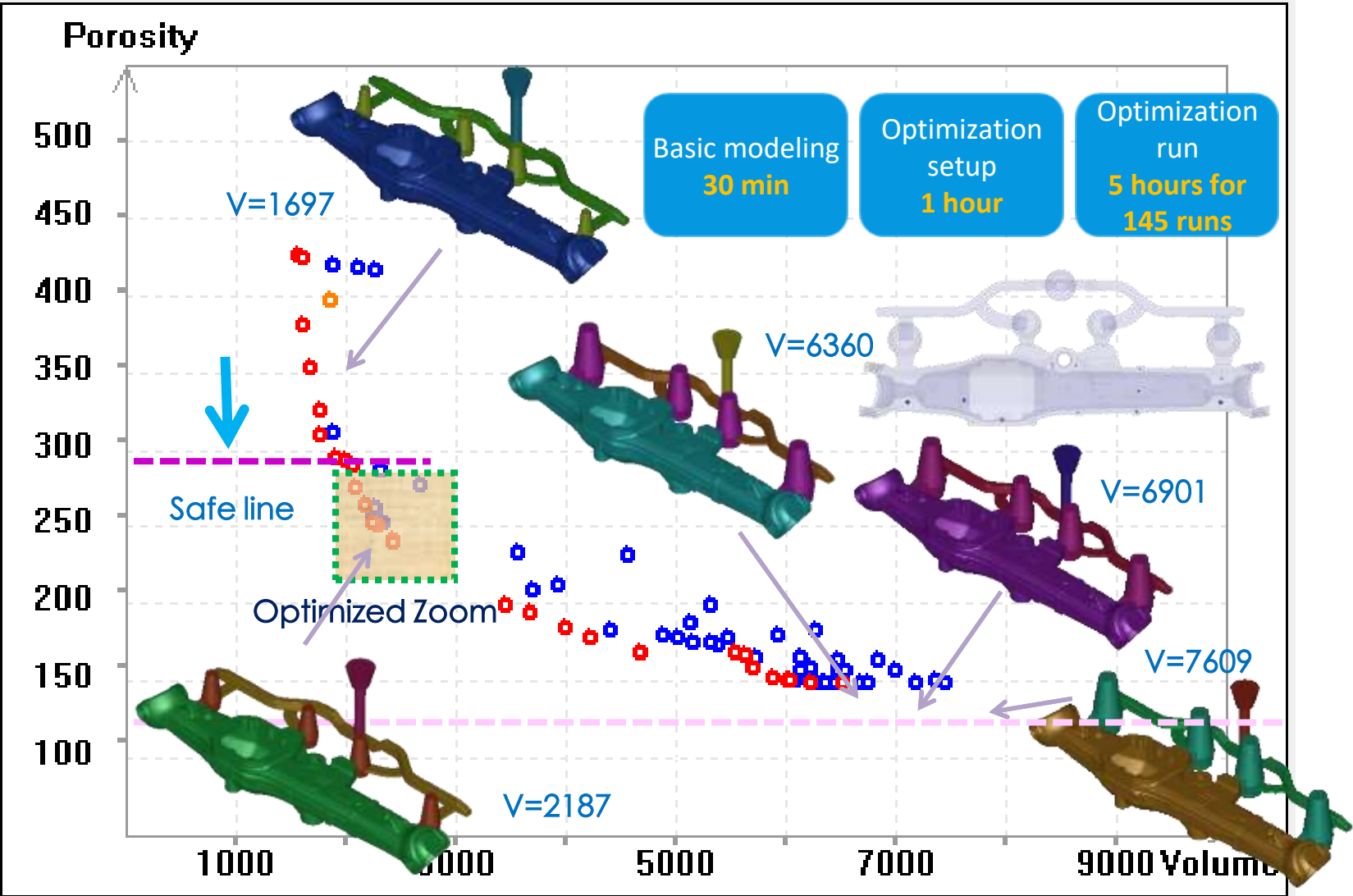
Variables	Start	End	Step
Chill	1	3	1
Feeder 1	1	3	1
Feeder 2	1	3	1
Riser	1	3	1
Pouring temperature	1540 degree	1580 degree	20 degree

Full combine models: 243 models Taguchi DOE method: 27 models
User defined condition could be applied to above two methods.
Setup the basic simulation model in 30 min and 1 hour for optimization setup. The 27 runs token 3 hours in 5 token parallel optimization in 20 core Intel E5 computer.

BENEFITS

CAST-DESIGNER Optimizer enables lower research expenditures and shorter implementation time. The main purpose of the system is to relieve a designer or researcher of the sufficiently complex and very labour-intensive process of searching for optimal system design parameters which simultaneously meet a great number of sometimes controversial requirements.

To optimize the casting yield ratio and shrinkage porosity of an automotive part. Using the GA method to find the Pareto front points. The X axis was the total riser volume and the Y axis was the total shrinkage porosity volume.



CAST-DESIGNER can perform the full couple simulation of thermal, flow and stress together. The stress simulation includes both thermal and mechanical stress, accurately predicts casting residual stresses and distortion.

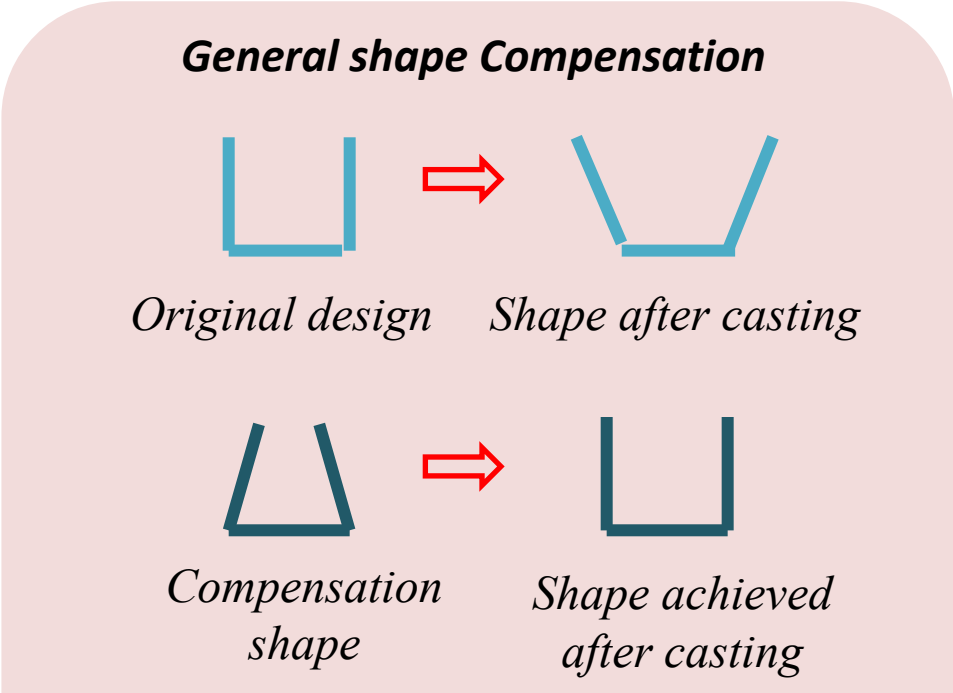
Automatic Distortion Compensation

In addition, with the stress module, the user can achieve the following goals:

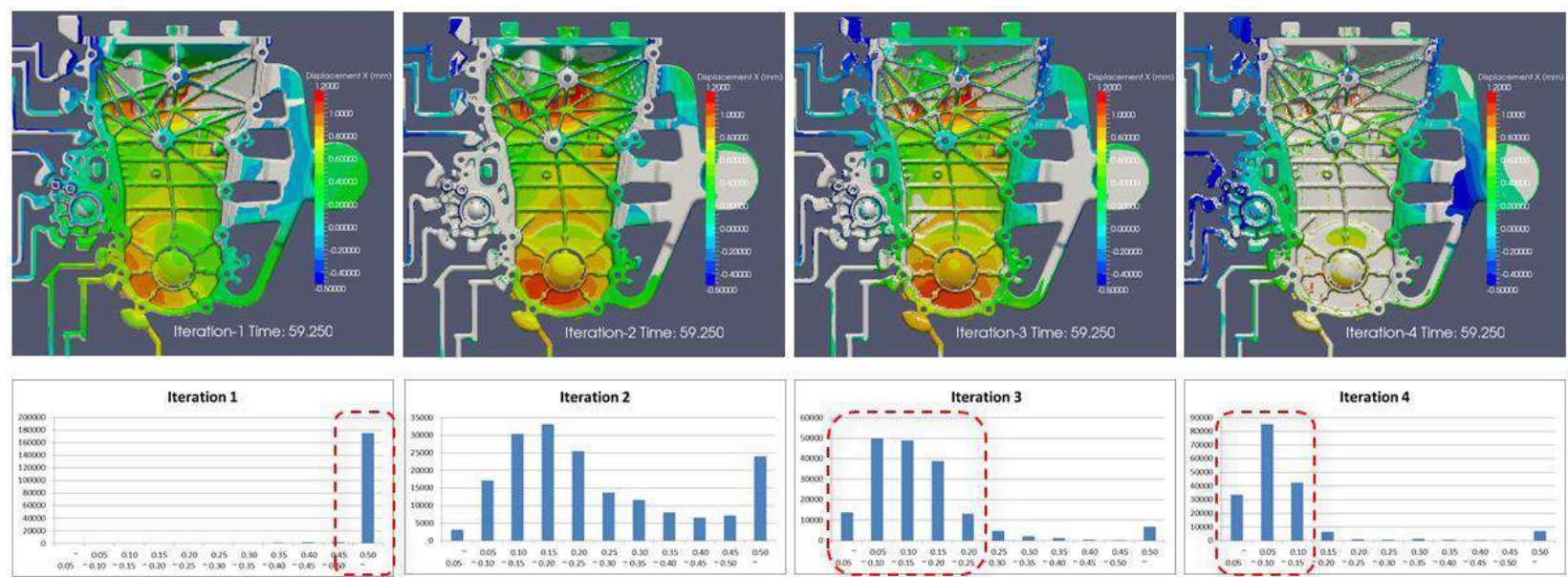
- Casting and mould stress & strain distribution
- Part deformation and distortion
- Gap formation between the casting and mould
- Predict elastic spring back
- Hot tearing and cracking indication
- Die life fatigue

DISTORTION COMPENSATION

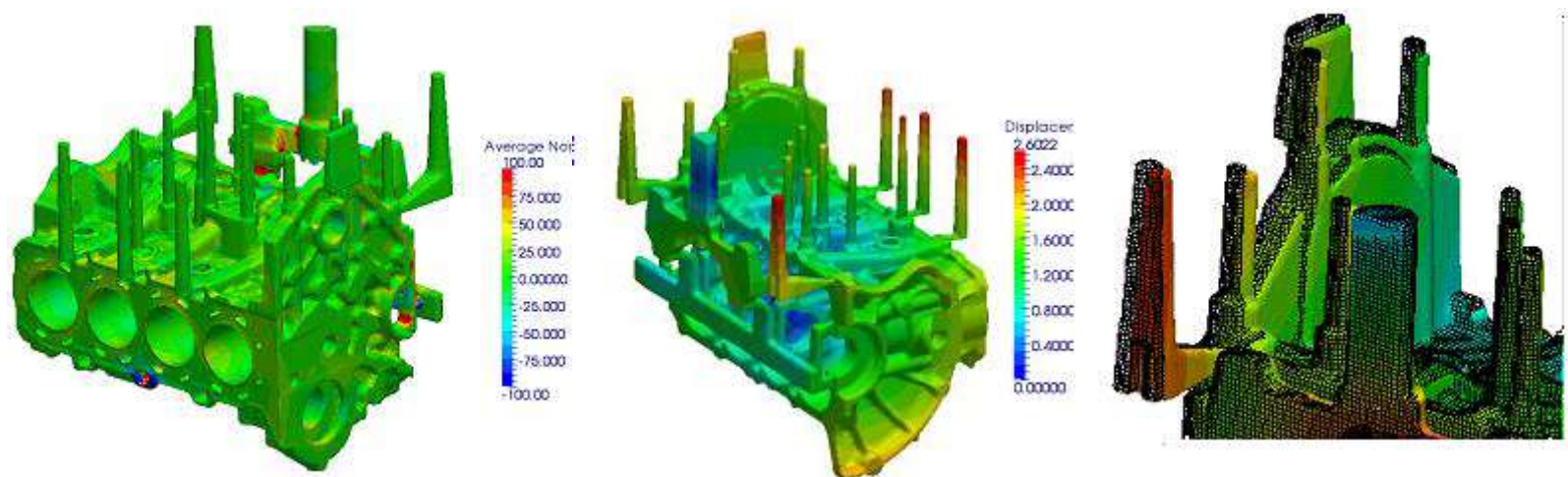
- In **CAST-DESIGNER**, A Distortion Compensation Solver (**DCS**) was developed based on the mechanical stress solver to find compensation geometry automatically.
- In DCS, user can select a set of Sensor points/ Critical points, where user wants to control the distortion.



- It is an iteration method to find the best geometry shape to avoid the distortion in the casting and the importance is given to the selected sensor points in the final casting.
- Finally the adjustment distance of feature points are reported and can be used in CAD system. It is an unique product in the market.



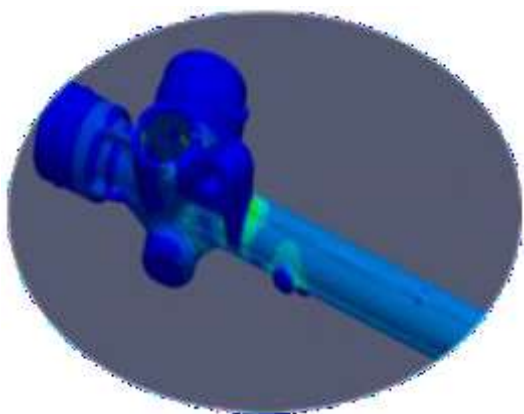
After the first iteration, the amount of deformation exceeded the tolerance and reached above 0.8mm. The flatness requirement of the product was 0.5mm. After four automatic iterations the product flatness is maintained between 0.05 and 0.15, and the product 100% meets the requirement.



Average Normal Stress

Displacement

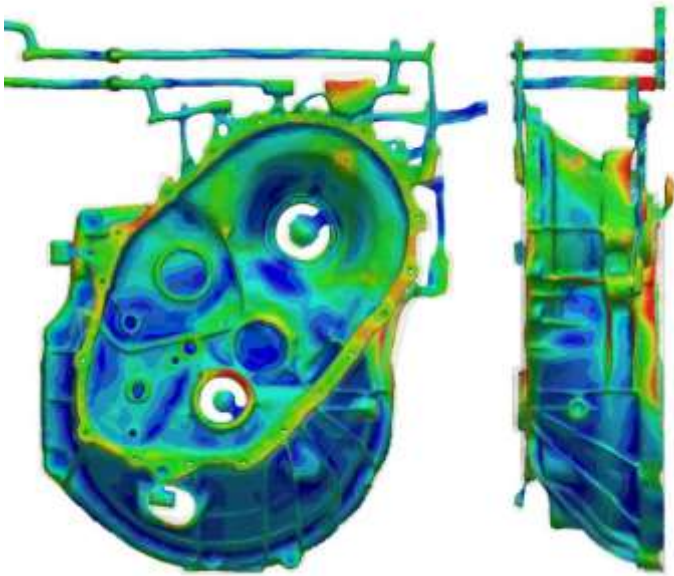
Displacement (close-up)



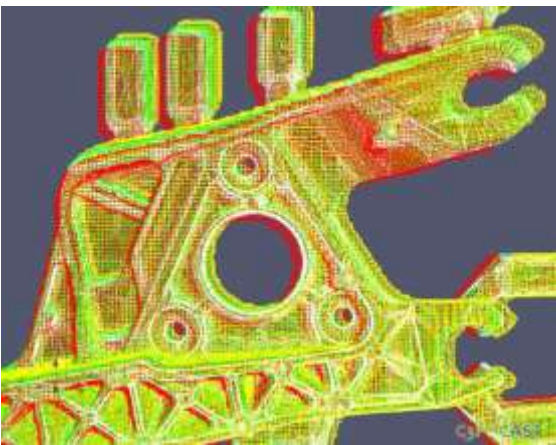
Hot-tearing indicated in simulation



Actual part failed at the same location



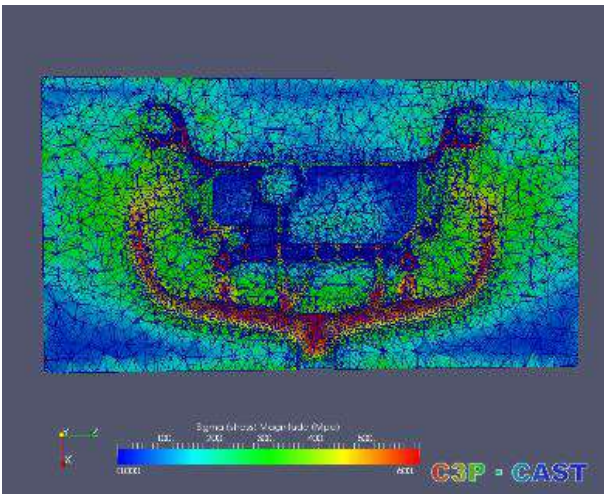
Distortion in HPDC Part



Compensation shape vs Actual design



Distortion in LDPC Part



Mould section stress

CAST-DESIGNER stress module helps casting part designers and die designers to consistently predict the dimensions of a casting part after cooling, with being able to closely predict casting dimensions will lead to

- **Better Part Design:** Helps designer to make better casting part design
- **Better Die Design:** Helps die designers to compensate for the part distortion during the die design stage. Thus, reduce the rate of scrapped castings
- **Quality Improvement:** Being able to closely predict casting dimensions will lead to tighter tolerance and thinner walls results in high quality castings and reduced scrap
- **Save Time:** Saves development time
- **Save Cost:** Reduces operation cost due to improved first shot capabilities and fewer number of interruptions
- **Improved Efficiency:** Better products with reduced cost help to redefine competitiveness

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

The thermal dynamic database calculator has over the past 30 years gained a world-wide reputation as the most powerful software package for thermodynamic calculations.

- Stable and meta-stable heterogeneous phase equilibrium
- Amounts of phases and their compositions
- Thermochemical data such as enthalpies, heat capacity and activities
- Transformation temperatures, such as liquidus and solidus
- Phase diagrams (binary, ternary and multi-component)
- Solidification applying the Scheil-Gulliver model
- And much, much more...

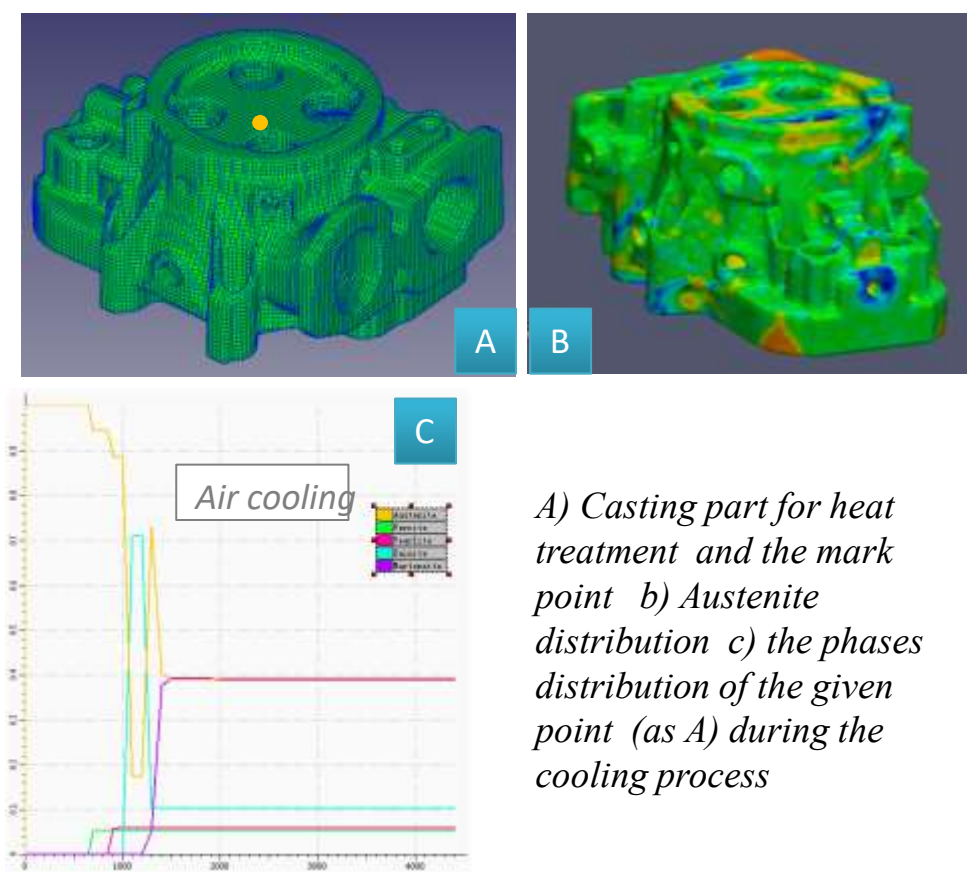
HEAT TREATMENT

CAST-DESIGNER

CAST-DESIGNER is the State-of-the-Art in heat treatment simulation software, promoting improved component and process design in heat treatment.

CAST-DESIGNER heat treatment simulation module is a coupled thermal, solid mechanics finite element based program for heat treatment simulation. Engineers can use **CAST-DESIGNER** to predict the residual stress state in a given part after heat treatment, the evolution and final volume fractions of metallurgical phases, hardness, and part distortion.

The **CAST-DESIGNER** analysis tool couples a multiphase material constitutive model directly with diffusive and martensitic phase transformation kinetics models.

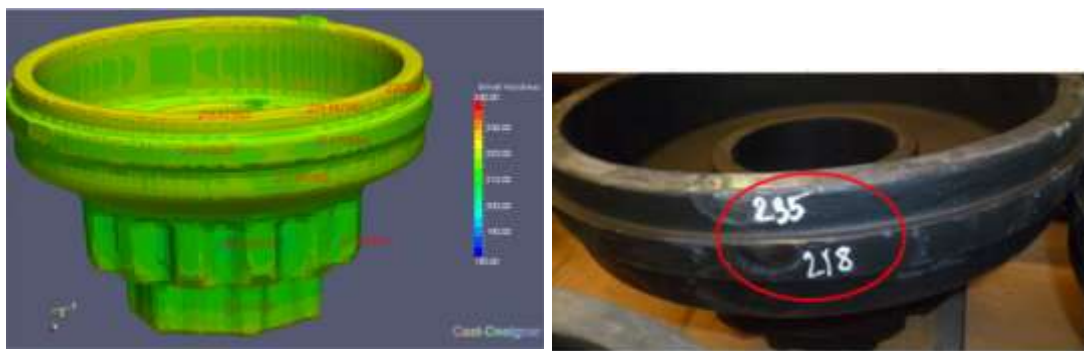


- Full compatibility with thermo-dynamic material database
- Generation of Kirkaldy-based TTT diagram for low-alloy steel grades
- Age hardening based on Shercliff-Ashby models for heat-treatable aluminum alloys
- Distortion models applicable to any kind of metal including aeronautic alloys
- Exhaustive results: temperature, phase transformation, HV or HRC hardness, distortion, residual stress, yield stress, carbon and nitrogen concentration, etc.

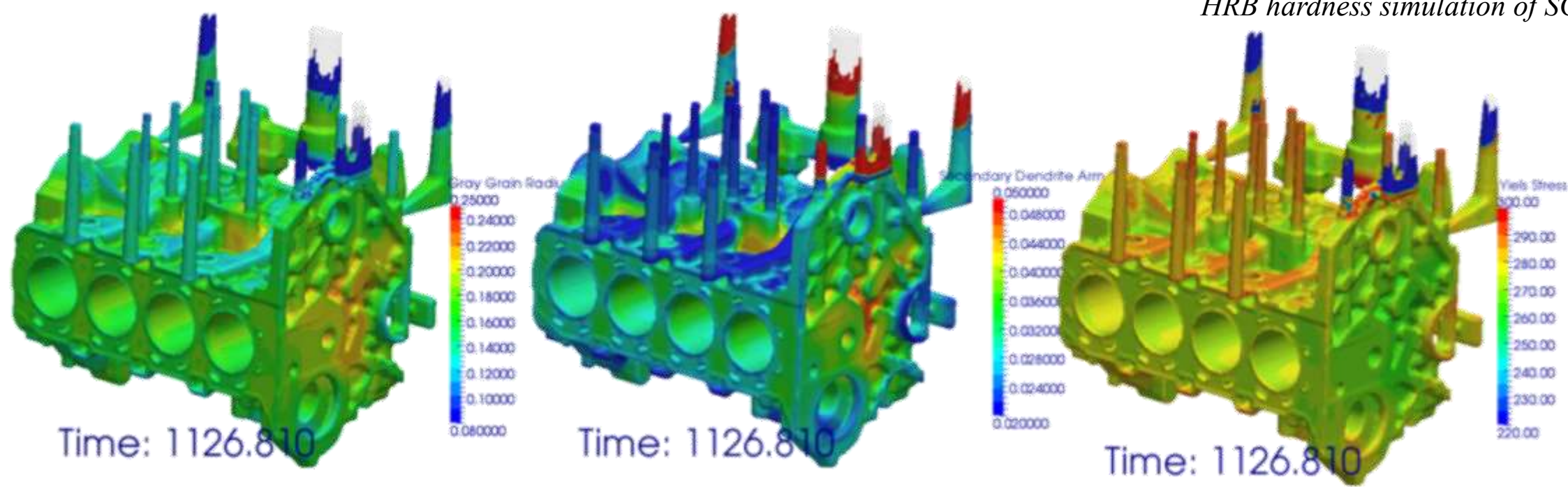
MICROSTRUCTURE ANALYSIS

CAST-DESIGNER

CAST-DESIGNER with a more comprehensive approach consists of running coupled, thermal microstructure and porosity calculations, including inoculation. The microstructure solver computes the evolution of different phases and predicts local density variations which provide more realistic porosity results. Specific microstructure models exist for different cast irons, such as GI, SGI, CGI and Ni-Resist.



HRB hardness simulation of SGI



Cast-Designer microstructure analysis result

PARALLEL COMPUTING

CAST-DESIGNER

Both the **CAST-DESIGNER** CFD solver and FEM solver can run jobs in parallel processing. The **CAST-DESIGNER** DMP solution (Distributed Memory Parallel) uses the latest available technology, in particular dynamic domain decomposition and message passing communication.

- Developed and optimized for the latest multi-core architecture
 - Parallelization based on the Hybrid MPI-OpenMP methodology
- True Domain Decomposition and automatic decomposition tool.
 - Optimized MPI communication and memory management.



Prediction of grain structure in casting solidification

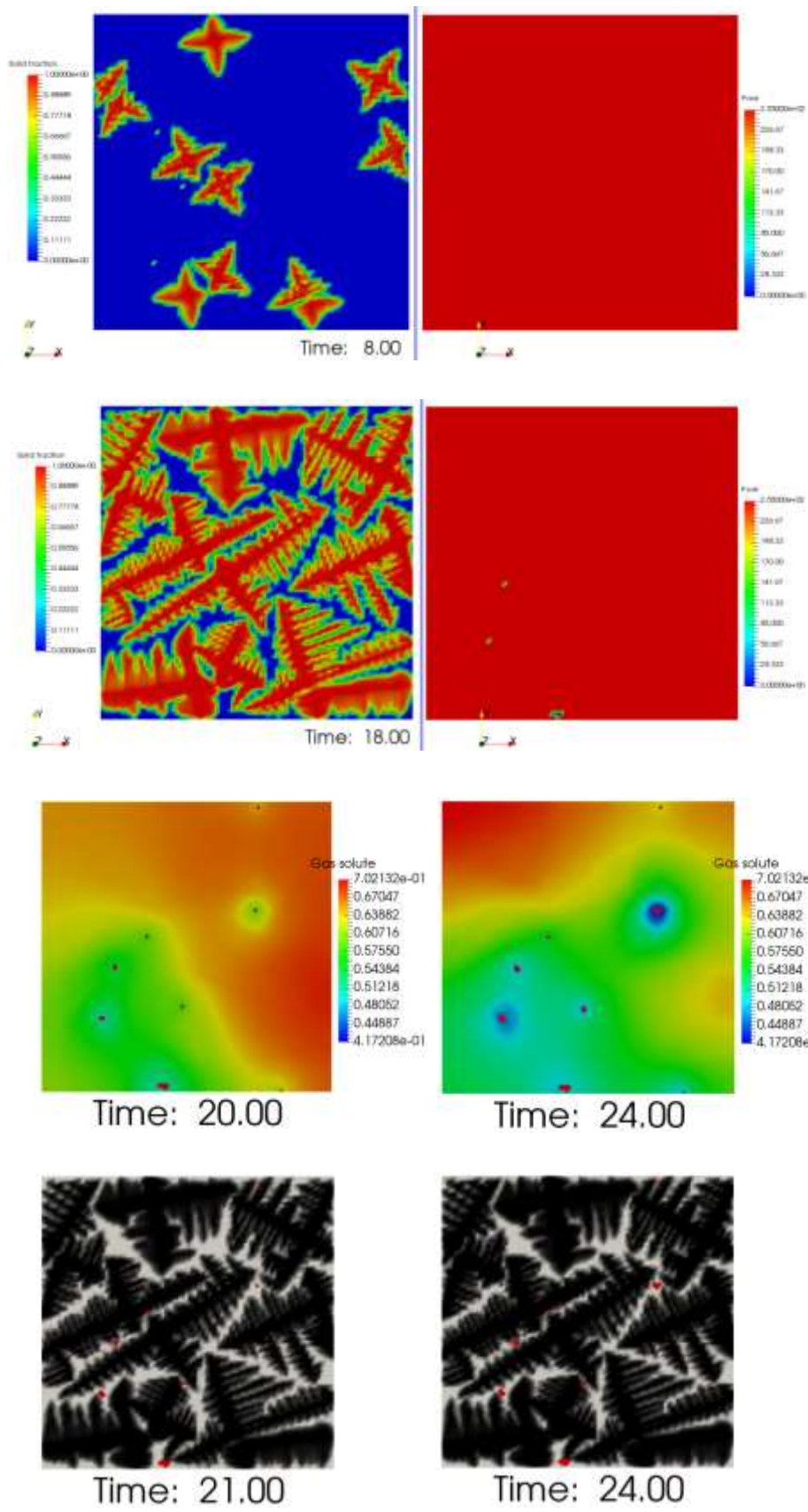
The CDCA (**CAST-DESIGNER** Cellular Automaton) model is a cellular automaton growth model combined with finite-difference solution of diffusion equations.

Porosity formation is classically divided in two stages: nucleation and growth. Both of them can be simulated with **CAST-DESIGNER** CDCA.

- Many physical phenomena occurring during solidification have been included in the CDCA model, such as:
- Pre-fixed nucleation of pores;
 - Stochastic nucleation;
 - Diffusion controlled growth;
 - Gas problems;
 - Couple the Marco model.

GAS POROSITY SIMULATION

Many components experience cyclic loading, where casting defects such as micro-porosity, intermetallic particles and oxide films can be detrimental to the fatigue behavior.

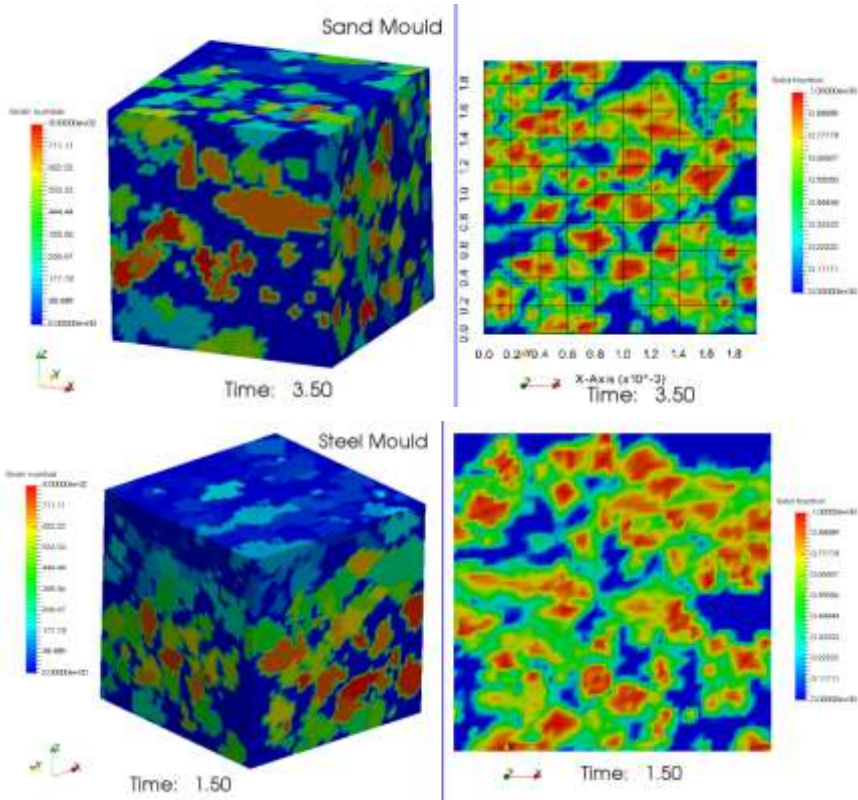


The CDCA model is able to predict the three dimensional morphology of porosity including shape, size, and distribution.

Growth of micro-porosity depends upon diffusion of hydrogen, shrinkage, and the interaction of the expanding pores with the surrounding dendrites. Therefore, the prediction of the morphology of porosity should consider the restriction of bubble growth by the solid phase.

COUPLE TO MARCO MODEL

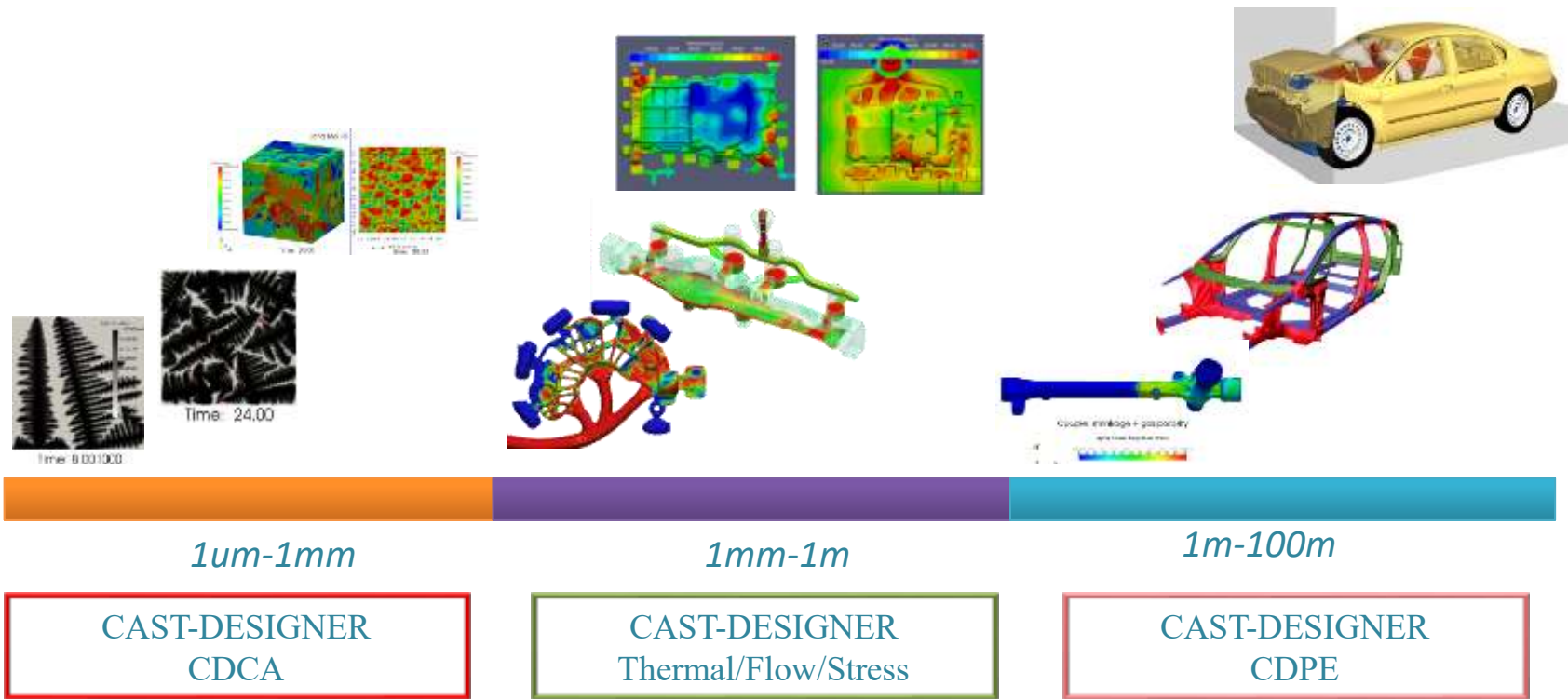
The reaction of the mould with liquid metal is sometimes unavoidable. Some alloys are very reactive, when casting these alloys it is necessary to consider the layer of impure material that will form at the surface. The mould area needs to be specified by inputting an image, or by coupling with a macro-model that can pass this information to the simulation routine.



The comparison of 2 Marco coupled models in different cooling rate: The sand mould and the steel mould.

- Run a standard **CAST-DESIGNER** simulation for the Marco-model
 - Usually solidification only simulation
 - Consider complex temperature distribution
- Check the Marco-model simulation result and run couple
 - Temperature distribution
 - Where is the key region need run CDCA
 - Result output frequency in the key frame should be small enough
 - Define the process start time and end-time
 - Start time: when to start CDCA couple (all liquid)
 - End time: when to stop CDCA couple (all solid)

multi-scale solution for full casting chain



Multi-scale modeling and simulation have become major tools in the design and optimization of novel materials and their processing. Casting microstructure evolution is difficult to describe quantitatively by only a separate simulation of dendrite scale or grain scale.

CAST-DESIGNER provides a whole solution with multi-scale coupling from um to tens meters in the same user's environment.

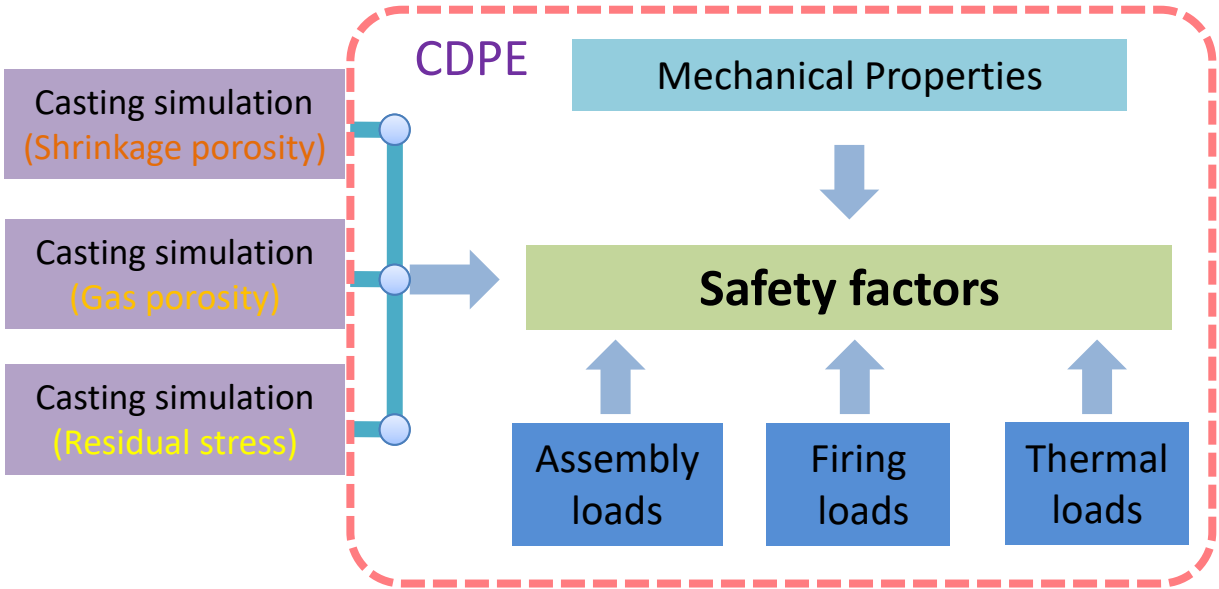
Couple the casting result to performance simulation

CDPE (**CAST-DESIGNER** Performance) is a software module for the solution of large-scale, 3-D solid models subjected to static and dynamic loads. The software includes specific features oriented toward the investigation of fatigue and ductile fracture in metals and non-metals.

CDPE is an analysis engine and fully integrated to **CAST-DESIGNER** user’s environment. The affection of casting defects to the final part performance could be considered well thanks to the full couple of **CAST-DESIGNER** solver and CDPE, such as the shrinkage porosity, gas porosity and residual stress could be mapped to CDPE solver directly.

CDPE MAIN FEATURES & APPLICATIONS

Function	Supported Contents	
Static linear	Including them alstress analysis	
Static nonlinear	Material	Hyper-elasticity/Thermal-Elastic-Plastic /Visco-Elastic /Creep, Combined hardening rule
	Geometry	TotalLagrangian/Updated Lagrangian
	Boundary	Augmented Lagrangian/Lagrangian multiplier method, Finite slip contact, Friction
Dynamic linear	Explicit method/ Implicit method	
Dynamic nonlinear	Explicit method/ Implicit method	
Eigen value	Lanczos method	
Heat transfer	steady/Non-steady (implicit), Material nonlinear	
Element type	Tetra/Hexa /Prism , Shell, 1st/2nd order, In compatible model, SRI	
Utilities	User's subroutine, Restart, Step control of boundary conditions	



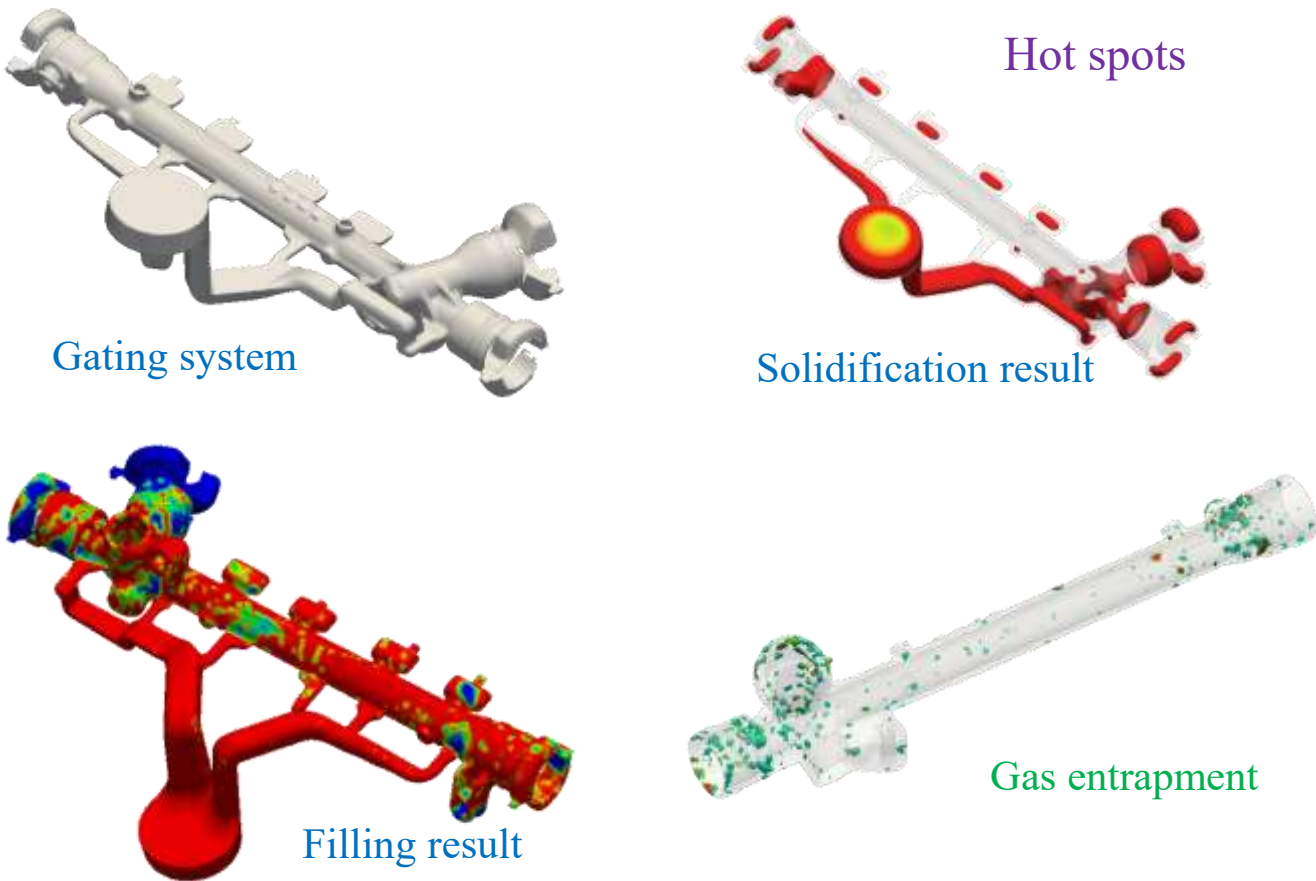
CDPE framework

- CDPE: Fully integrated to **CAST-DESIGNER** system
- Same user environment , same data structure
 - Same mesh system , same CAD data
 - Automatic result coupling, no data lose.
 - Format from/to Abaqus, MSC Nastran and NEI Nastran.

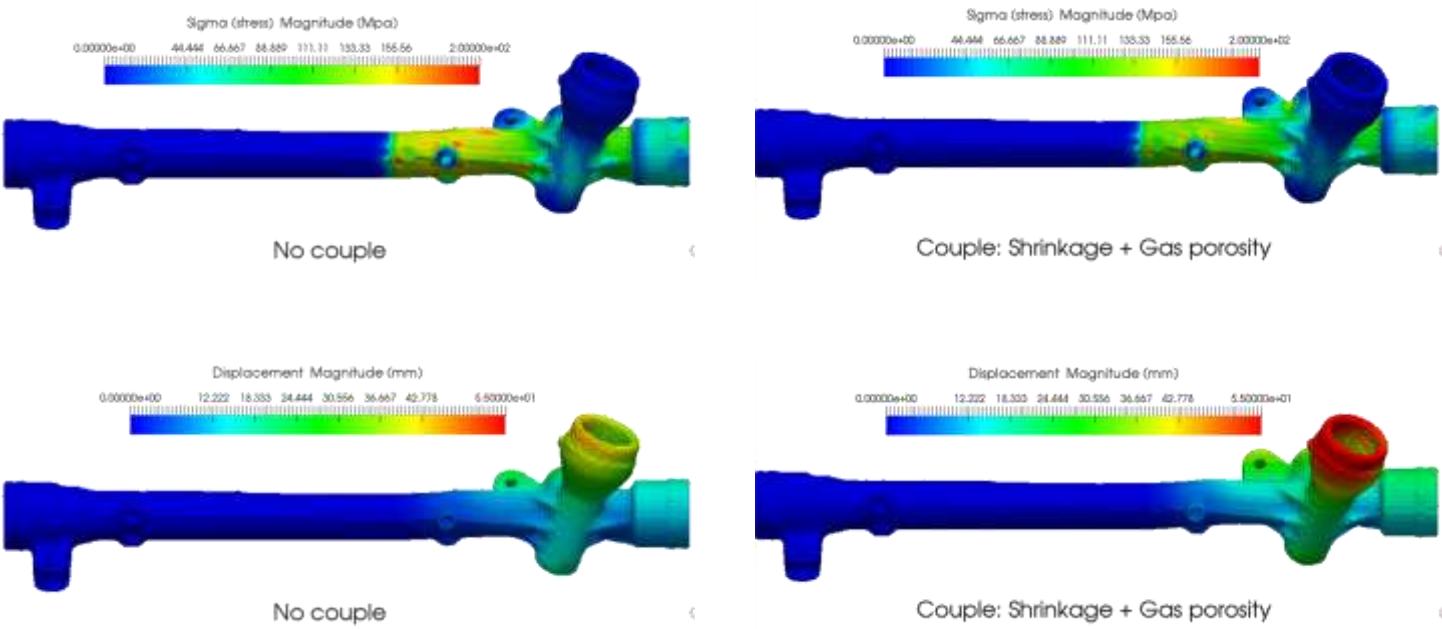
Advance Characteristics

- **Assembled structure:** MPC-preconditioned iterative solver, finite slip contact, friction
- **Multigrid method:** Convergence acceleration utilizing hierarchical meshes
- **Enhanced parallelism:** Efficient parallel computation using more than 1000 nodes
- **Parallel solver:** Preconditioned iterative solvers/ Parallel direct solver
- **Parallel visualization:** Surface/volume rendering
- **Coupled analysis:** Fluid-structure analysis with CFD

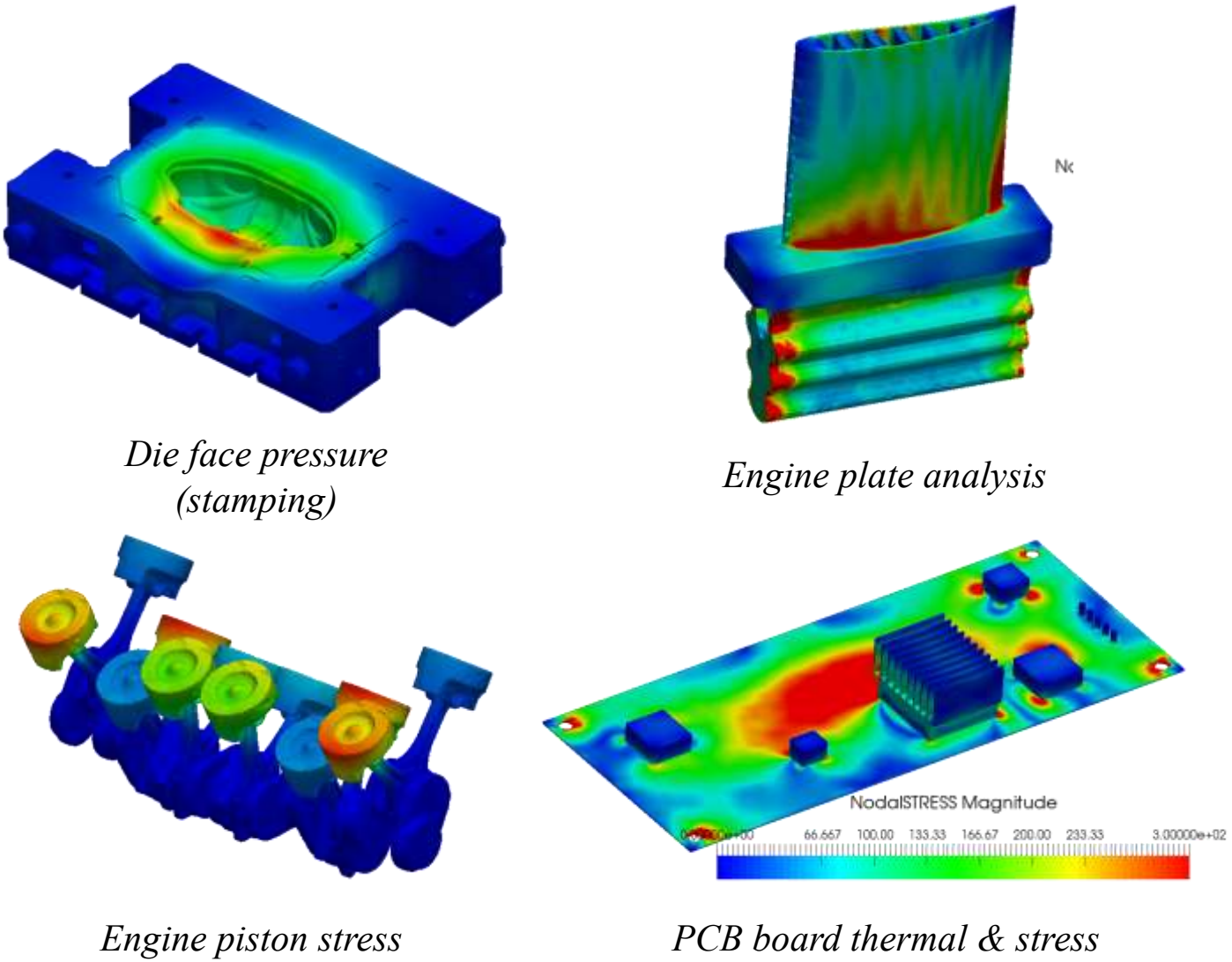
Casting Process & Defects



CDPE Result



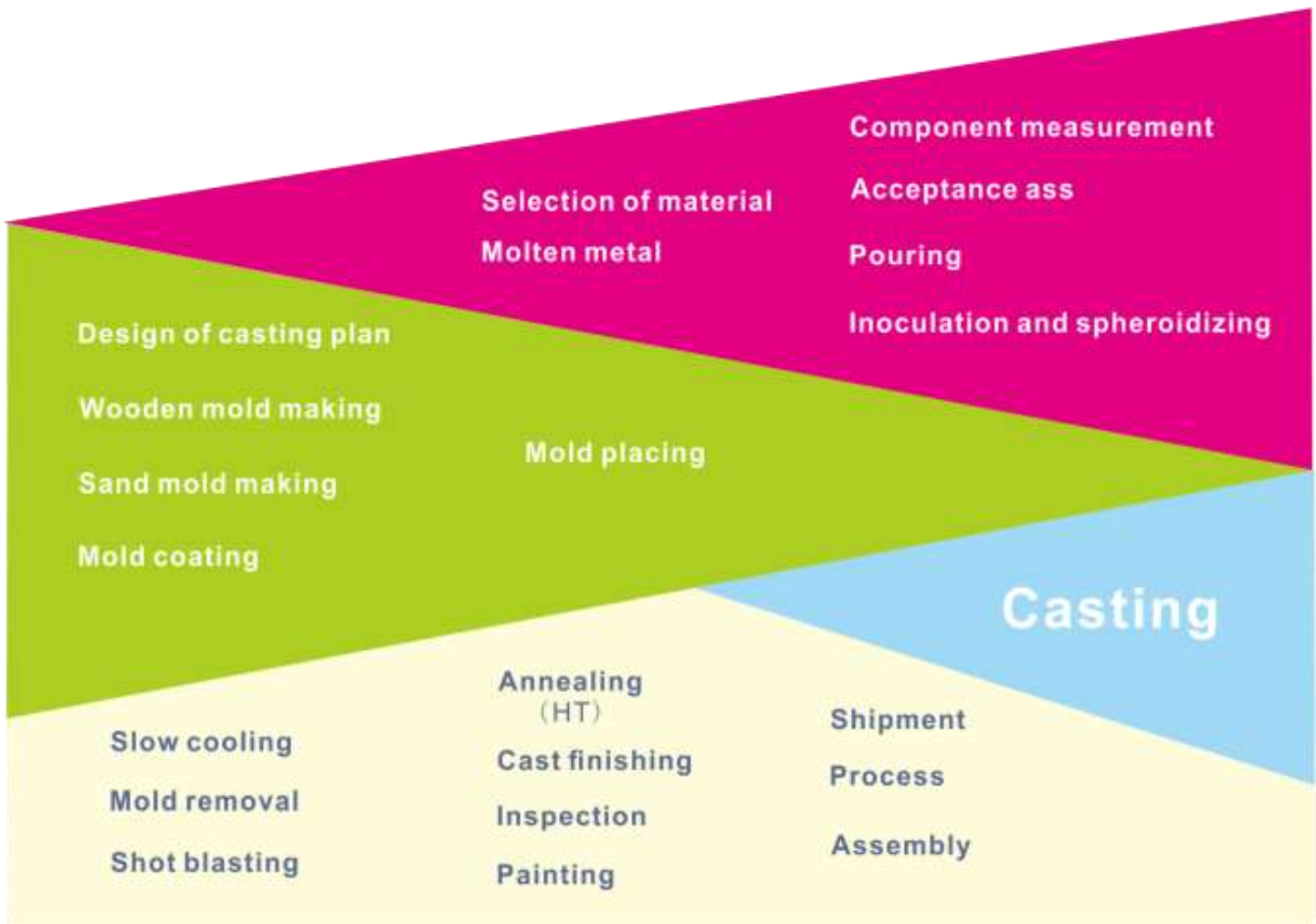
CDPE Applications



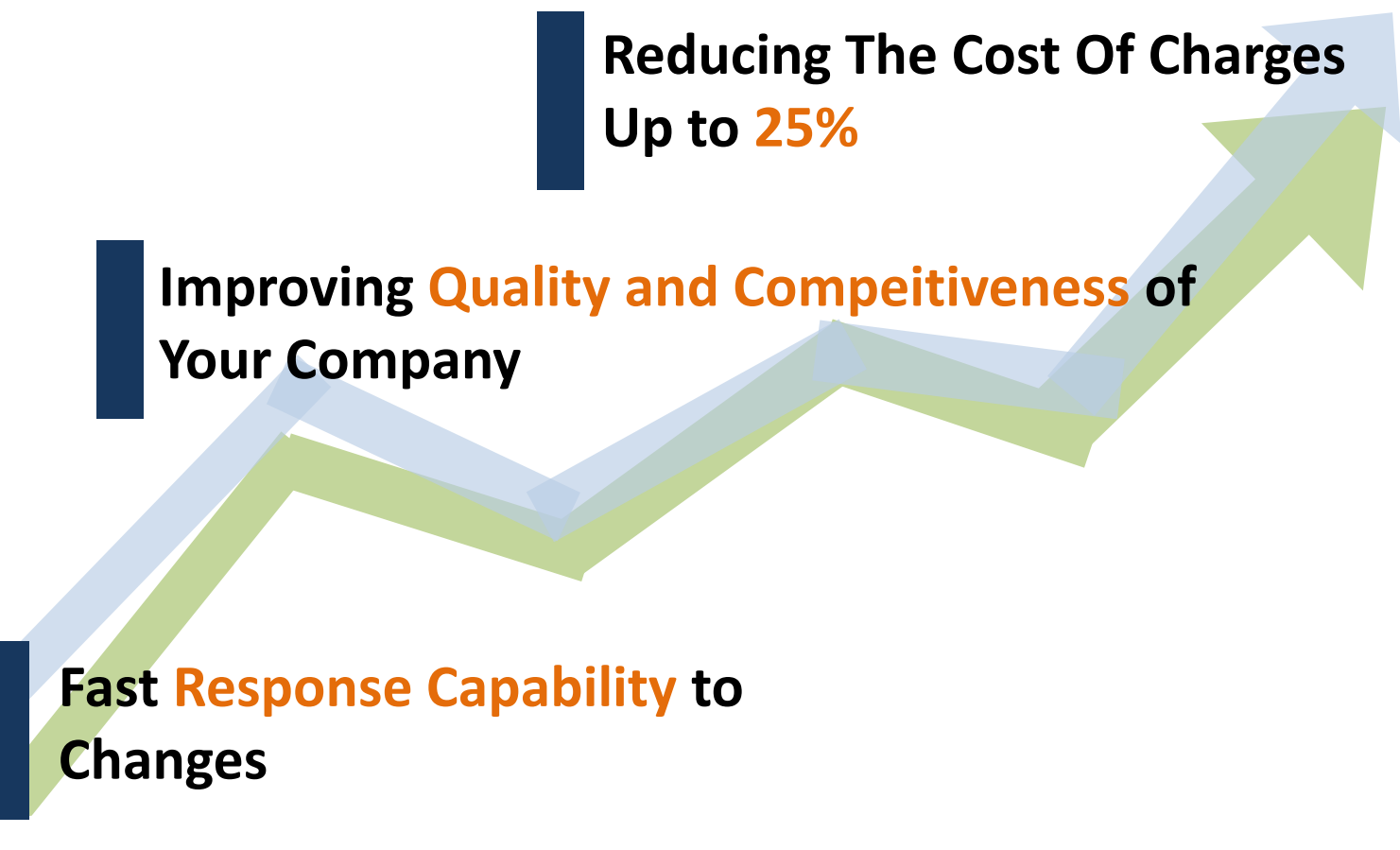
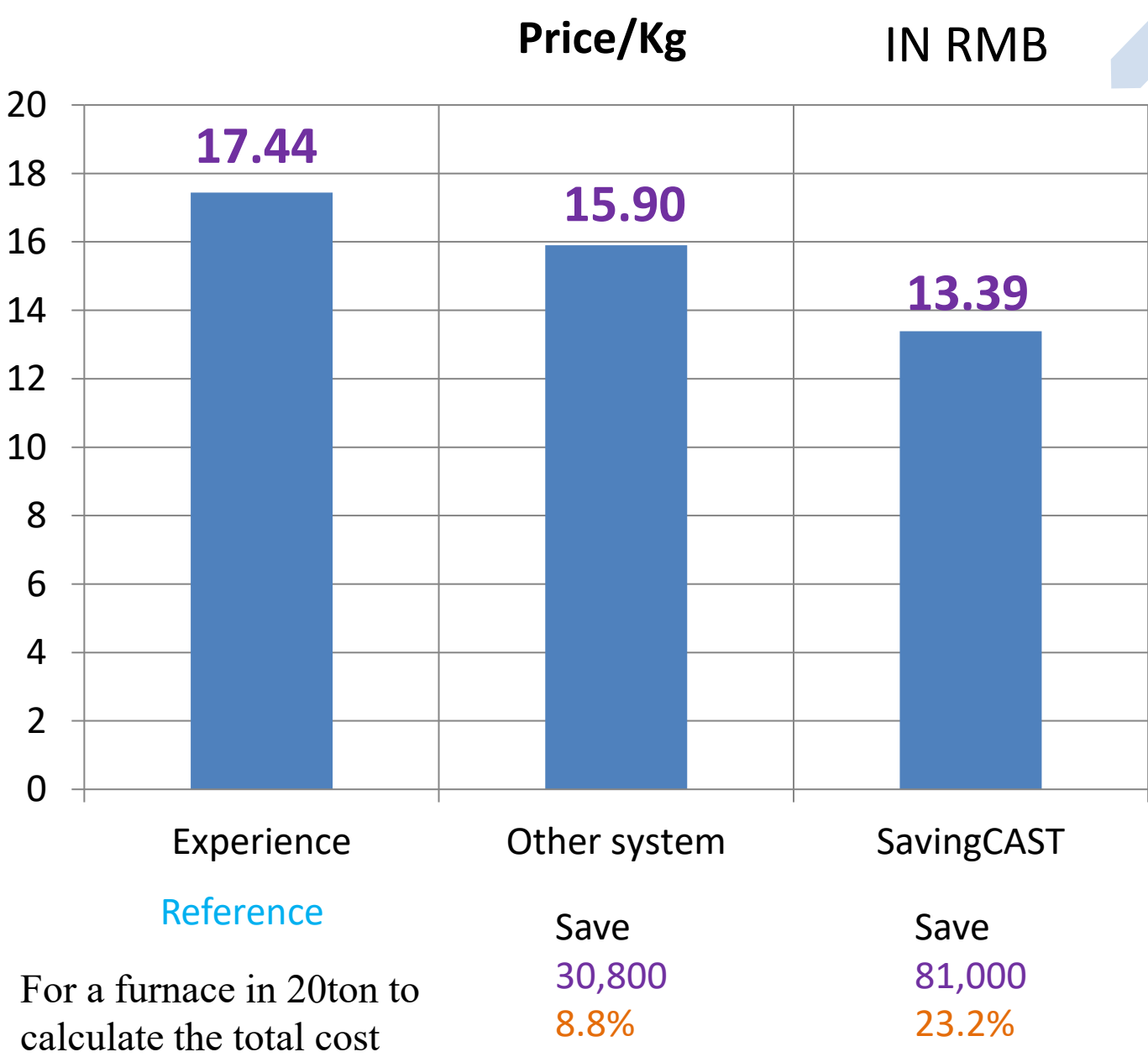


SavingCAST is a software specially developed for foundries, designed for optimal selection of ingredient materials for a user defined alloy composition for a specific load within the available stock materials.

- For Example: Scrap materials may contains expensive ingredients. Find out the best mix of scrap grades, fresh raw materials, ingots, to arrive at the required composition of alloy material. Mix of ingredients are selected based on cost and composition of various scrap materials available in stock.
- Automatic calculation of casting with cost optimization using the relevant information of the raw material in stock, always within the constraints imposed by the user.
- SavingCAST will let you prepare your charges at the lowest cost, saving time, avoiding human error, managing the stock and keeping track of your operations.
- SavingCAST is suitable for all casting processes.



Charging Example – Steel charging



FUNCTIONAL FEATURES:

- Working with the unlimited list of charge components;
- Charge calculation for any multi-component alloys;
- Calculation of the charge optimum structure at minimum cost;
- Charge calculation on the basis of an average chemical composition of an alloy, within the limitations set by standards;
- User defined databases of alloys and charge components;
- High speed of computing processing;
- Flexible result analysis tools;
- Calculation result report transfer to MS Excel.



MATHEMATICAL FORMUIAS MANAGEMENT

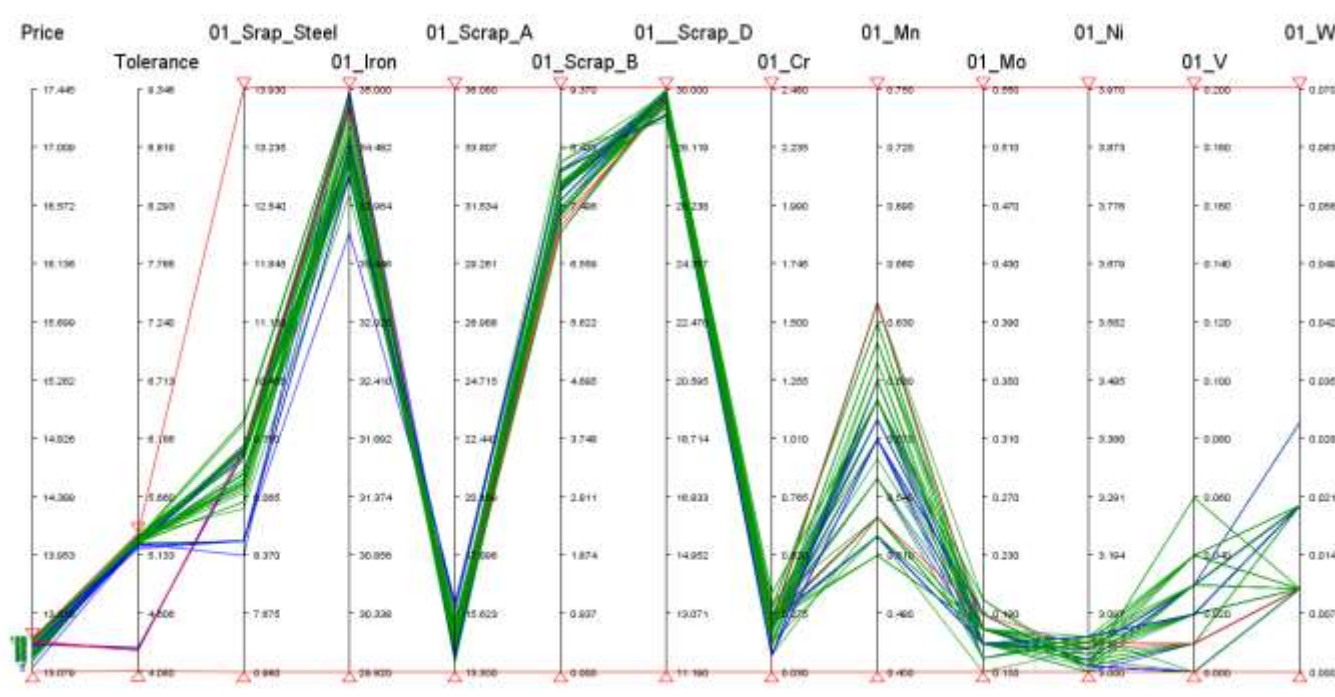
Because sometimes it is not sufficient to specify the limits of chemical elements one by one, any formula that makes relations among them will be respected by **SavingCAST** when optimizing castings.

ADVANTAGES OF THE PROGRAM:

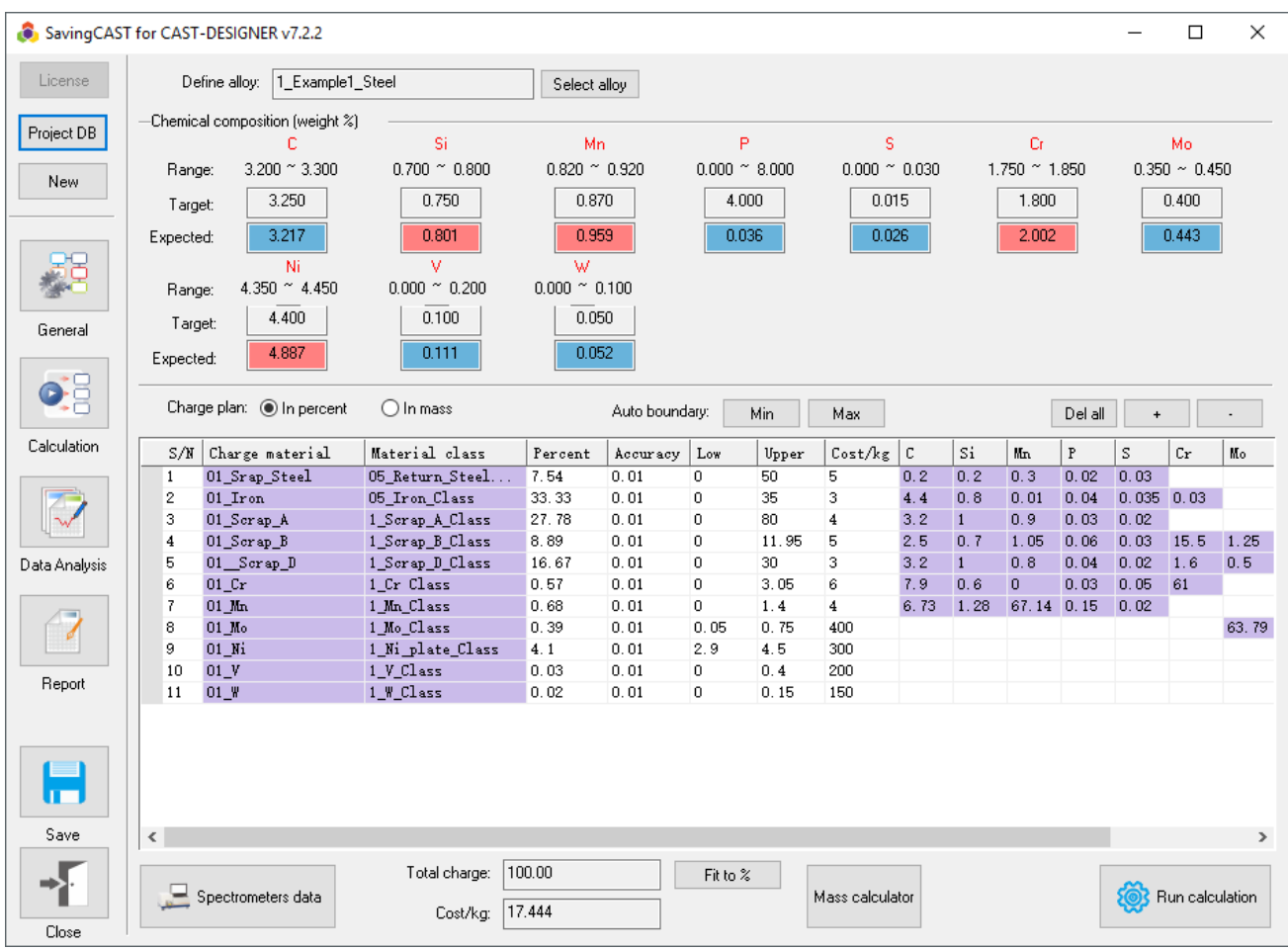
- Efficiency and speed of calculation within the process of production and under constantly changing assortment of charge materials and alloying additives;
- Graphics plot for the optimization result;
- With mechanical properties module, to analyze the influence of factors to final mechanical properties;
- Multilanguage interface of the software.
- Flexible business plan for the software license.

SYSTEMS INTEGRATION

SavingCAST is able to prepare any casting at optimum cost, adapting to a specific production and recording the date information. It can also be integrated into any ERP/ database and spectrometer.



Parallel coordinator to select the best charging plan and robustness.



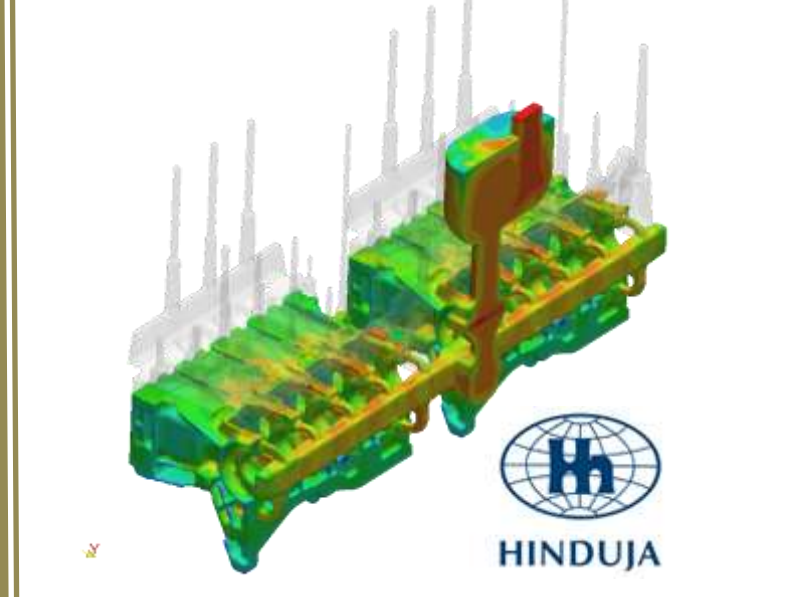
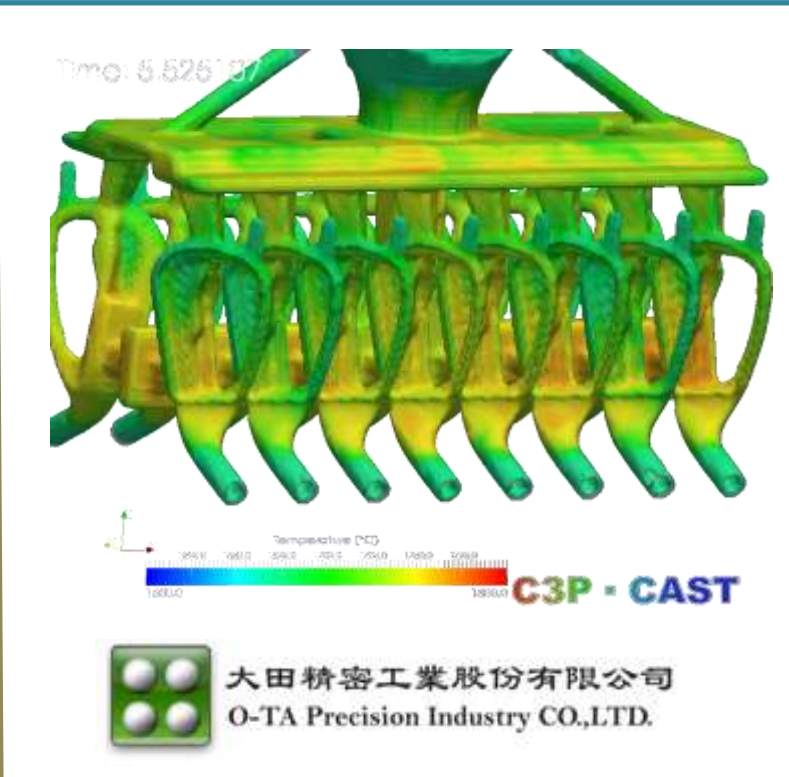
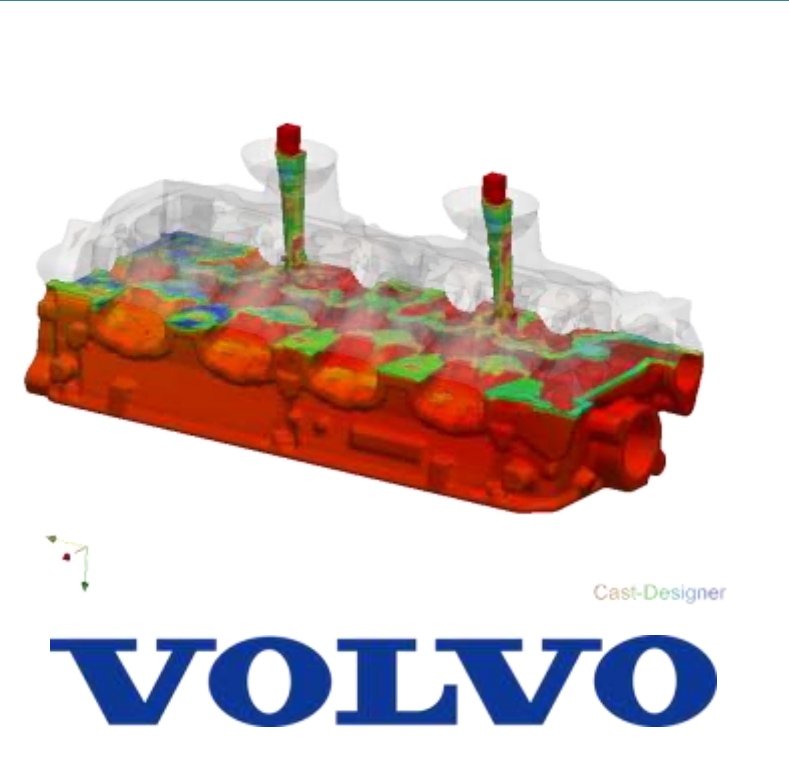
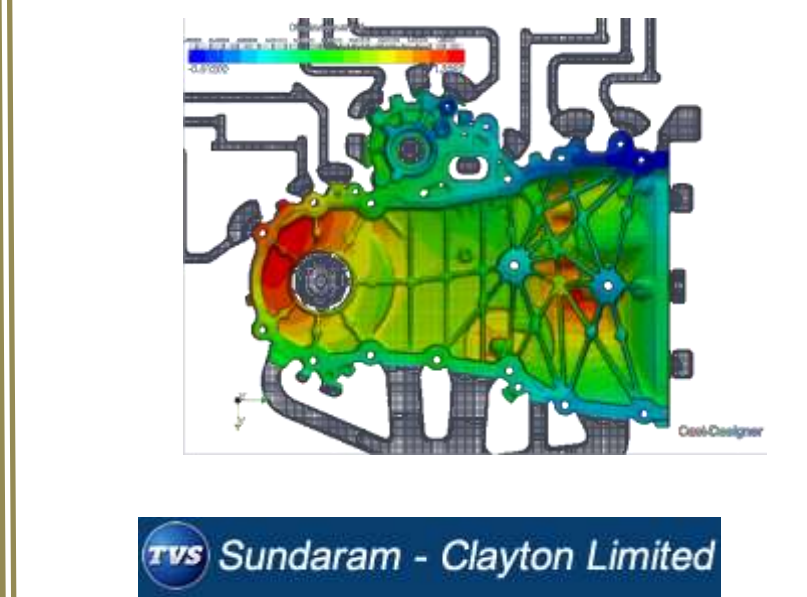
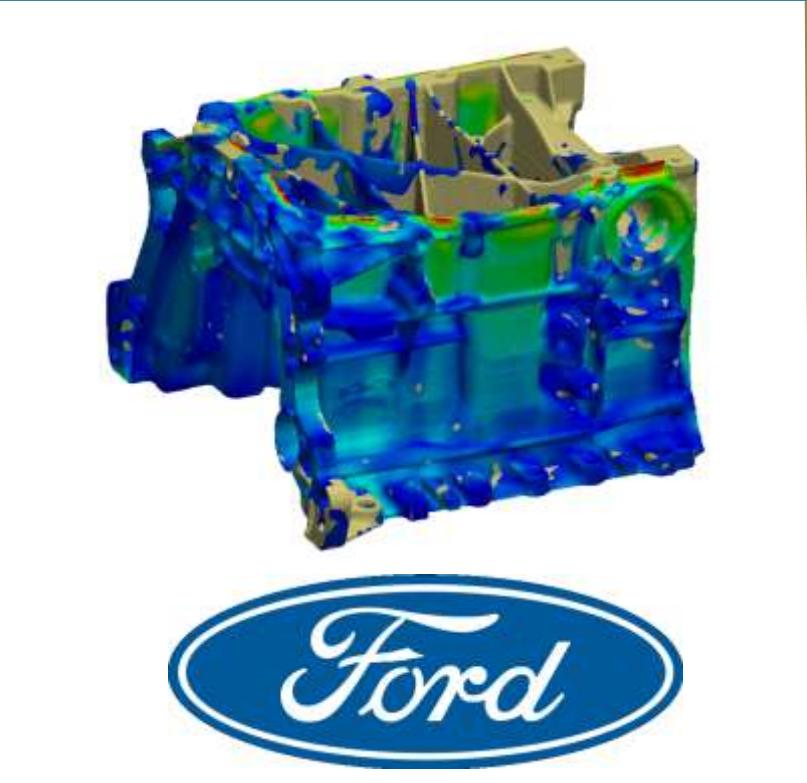
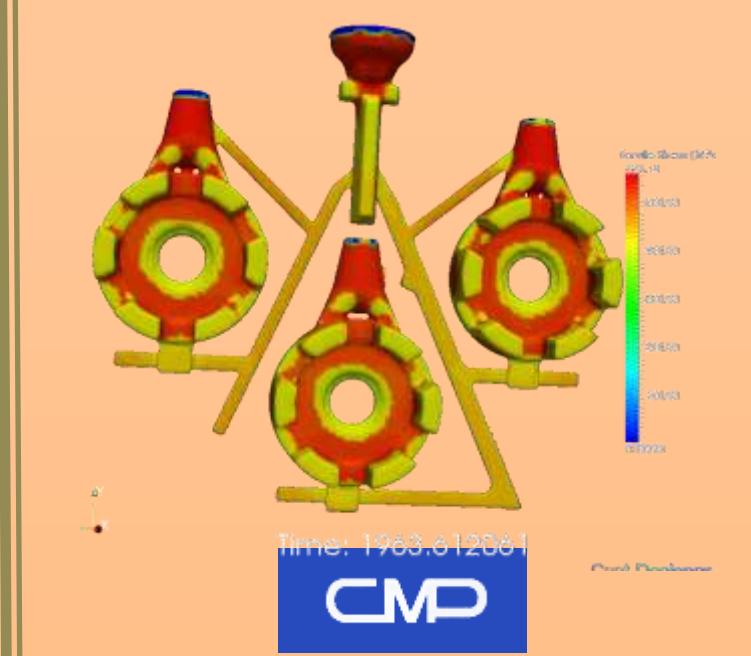
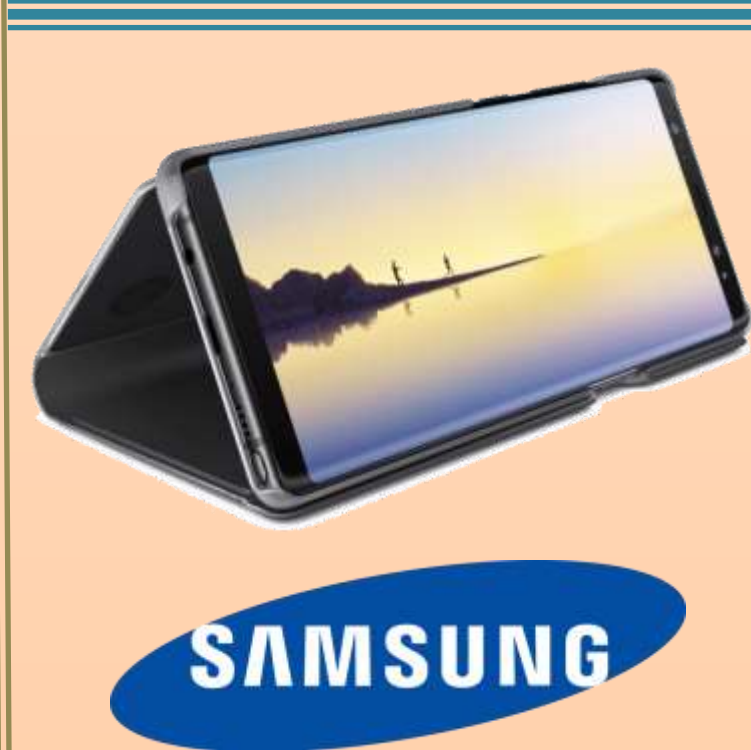
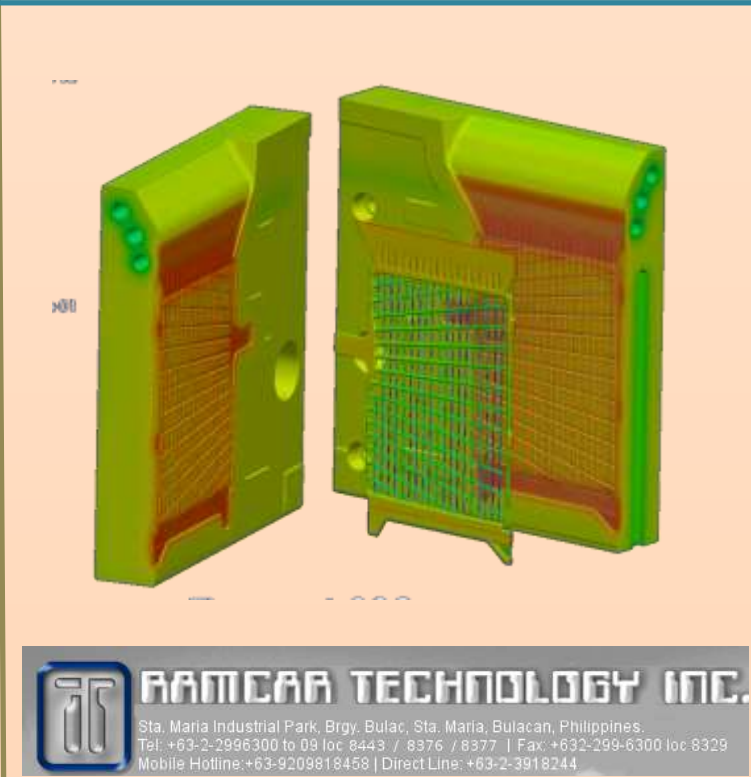
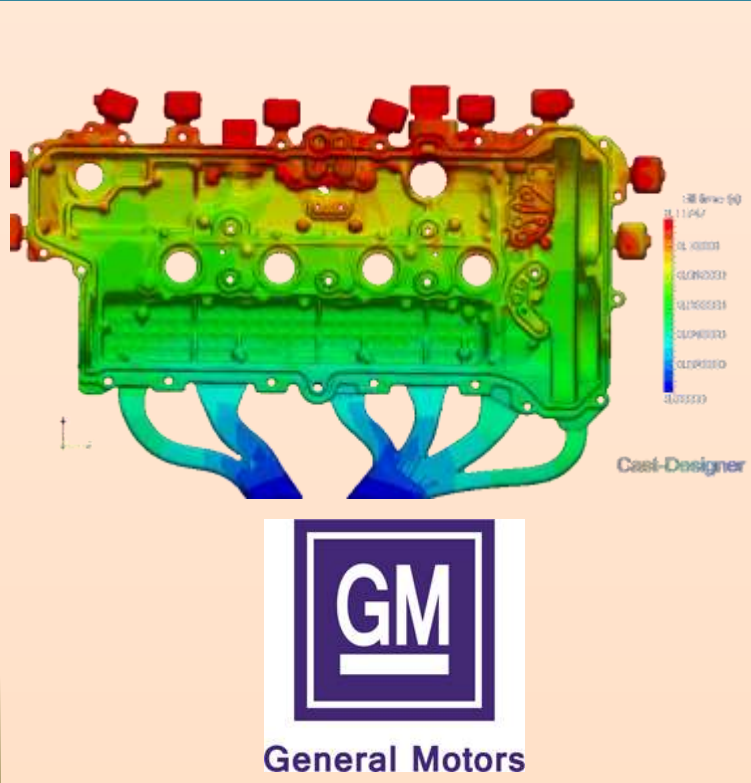
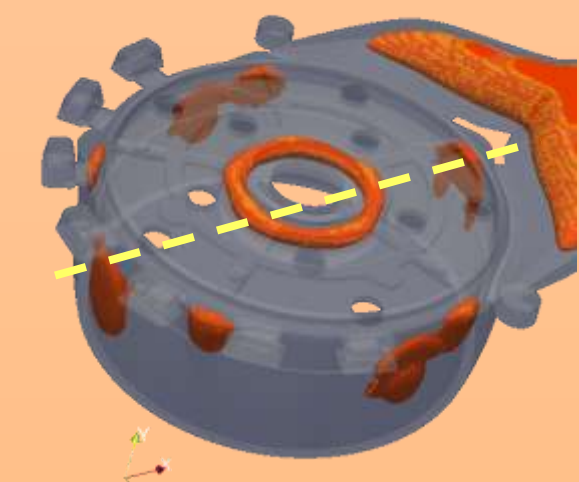
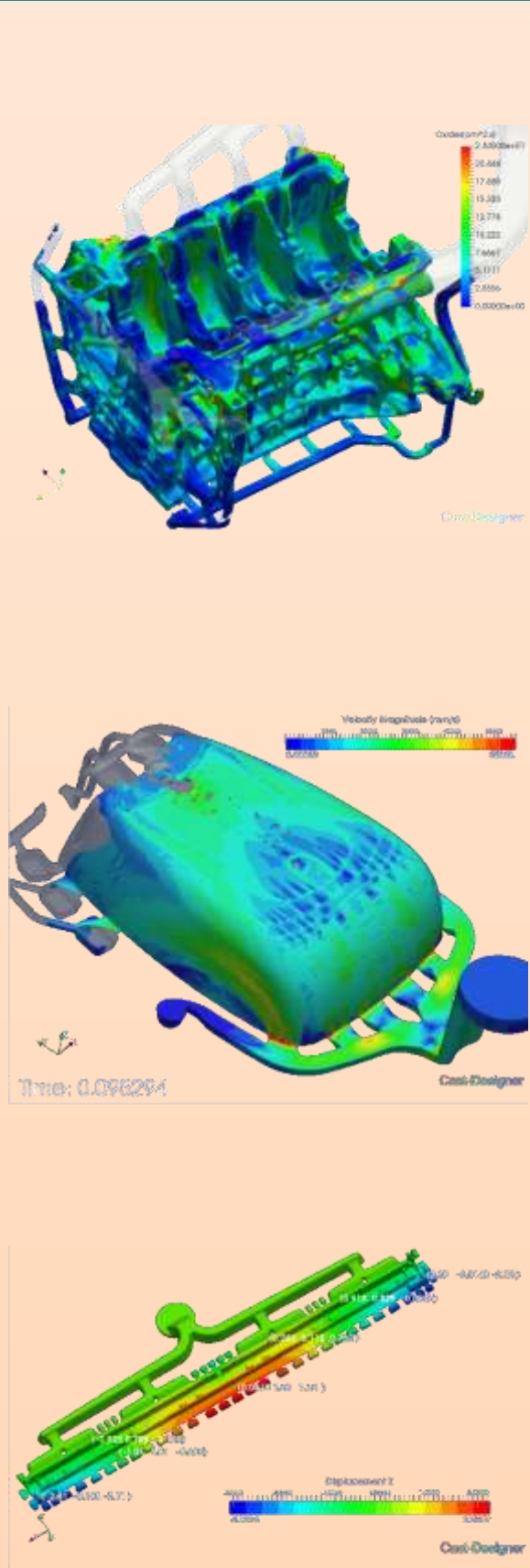
SavingCAST main interface

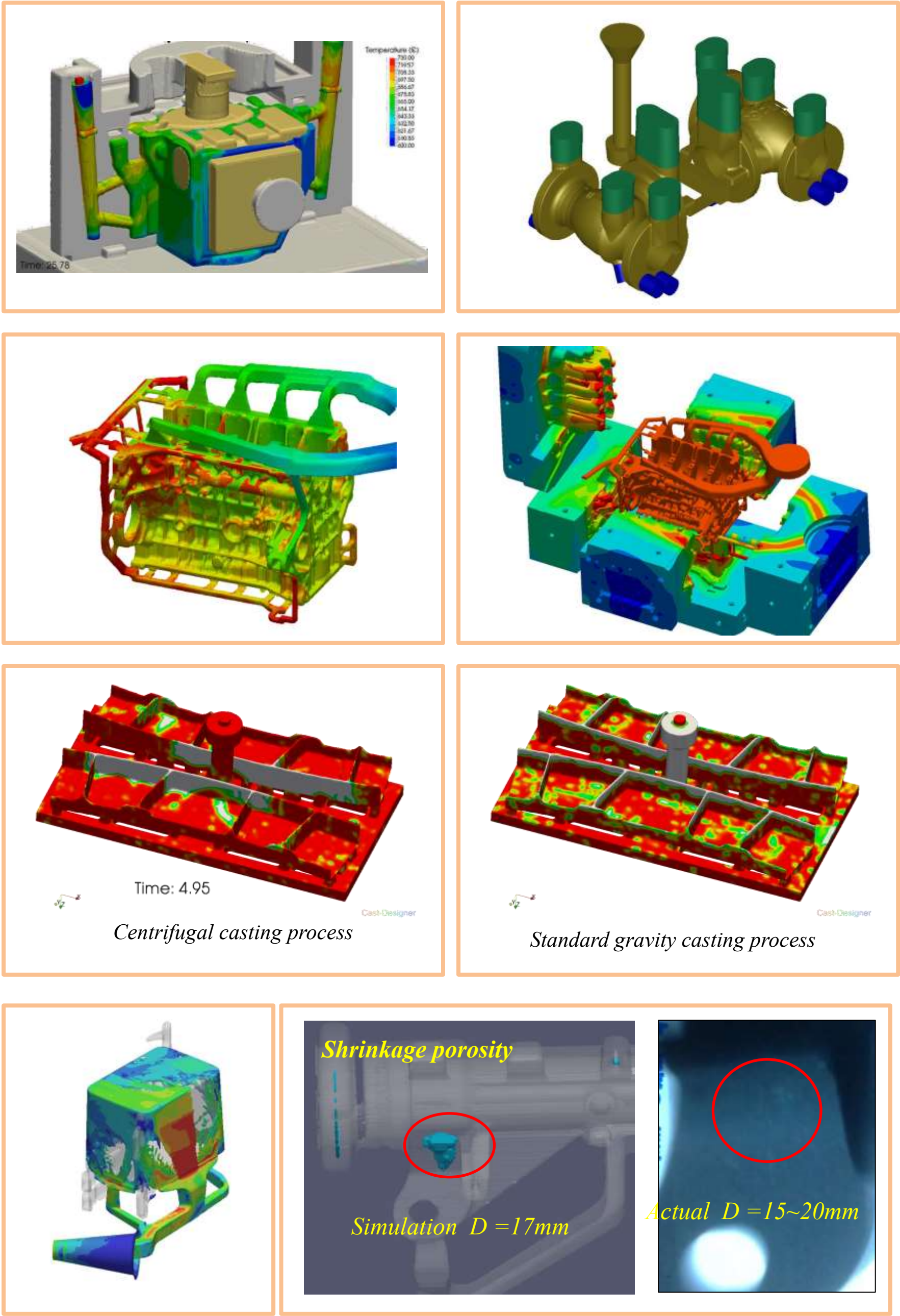
CAST-DESIGNER QUOTATION

- The quotation module establishes technical and commercial parameters concerned with the operation of the casting mould in production.
- It could be used for the quotation stage for price estimation or the production phase for detail cost control.
- This quotation calculator was evaluated by many customers in different casting field.
- The user can customize the currency, alloy, machine and manpower cost, then calculate the casting cost based on the production rate, volume, manufacture cost, and other operation cost. Finally a multi-language quotation sheet could be generated in Excel file.

CAST-DESIGNER

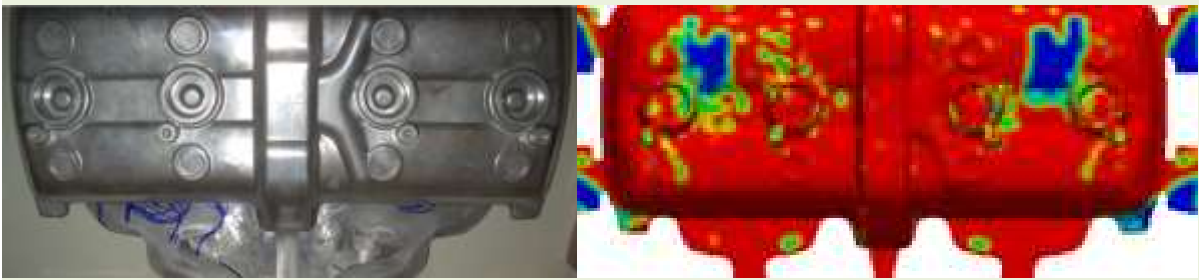
Casting Production Cost sheet			
Project Information			
Product:	Part	Part Name:	Cover-1
Part Number:	1234-12C1	Enquiry No:	N457865
Customer:	ABC Co., Ltd	PO No:	N457865
Prepared By:	Michiale W	Date:	2017/12/21
Comments:	Demo		
Casting data and production rate		Machine and casting alloy:	
Mass of casting:	3 Kg	Casting machine:	Ton350
Mass of gating system:	1.5 Kg	cost per hour:	9.8 /hr
Cycle time:	65 Sec	Cost of operator:	12 /hr
Number of Cavities:	1	Casting Alloy:	
Production rate:	55.4 pcs/hr	ADC12	
Annual quantity of part	400,000 pcs	Currency Used:	USD
Production batch size	40,000 pcs		
Cost of manufacturing process		Cost of movement and storage	
Machine cost	0.187 /pcs	Goods movement cost	0.007 /pcs
Labour cost	0.206 /pcs	Goods despatch cost	0.004 /pcs
Material cost	4.05 /pcs	Storage cost	0.003 /pcs
Scrap cost	0.04 /pcs	Freight cost	0.57 /pcs
others	0.083	F&A cost	0.1 /pcs
Subtotal	4.566	Subtotal	0.684 /pcs
Selling cost and sales price		Revenue and profit	
Selling cost	0.184 /pcs	Annual sales value	2,400,000.00
Selling price	6 /pcs	Annual total costs	2,173,600.00
Profit margin	9.43% /pcs	Annual profit:	226,400.00



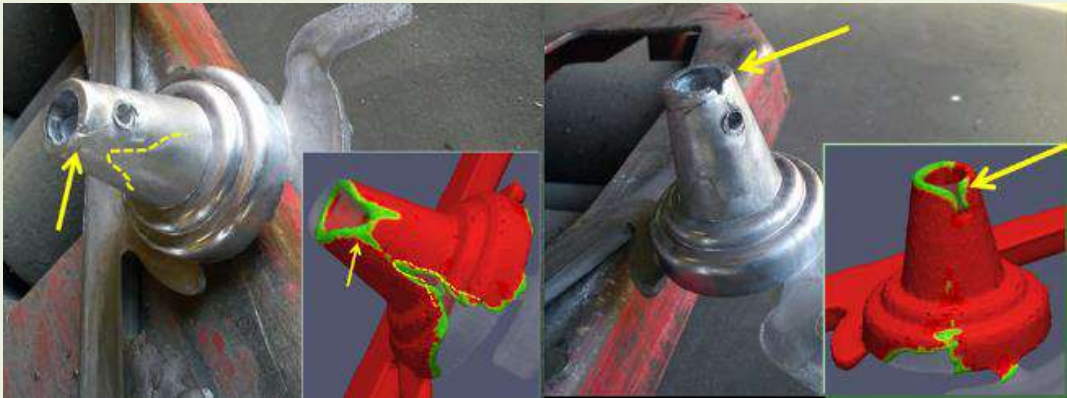


REFERENCES

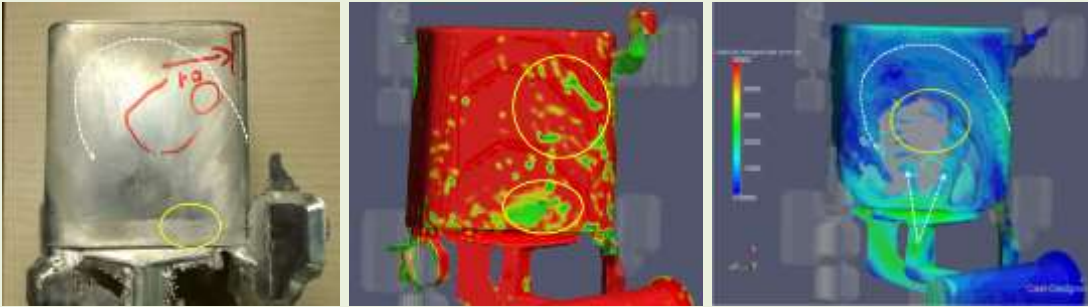
AIR FORCE RESEARCH LAB, AIT, ALTUM, ALUTECH, AURANGABAD ELECTRICAL, AUTO DIE CASTING, BANGDA, DUELL MOTOR CYCLE, CELIKEL, CFG, CHENGLING, CHICAO WHITE METAL CASTING, CHUANG YUAN PRECISION MOLD, DAIMLERCHRYSLER AG, DATIAN, DEYIDA, DIETECH, DINGSHI MOULD, DONGYANG, EFILTEK, EKO, ELTEX, EVORA, EXCO, FORD MOROR, FU HSIUNG METAL, FUHE, FUJI DIECAST, FUNDICAO, FUXIONG, G4 SOLUTION, GENERAL MOTOR, GUANGHUI, HAOFENG, HENGTONG MOLD, HINDUJA, HKPU, HONDA, HONGTE, HPMC, HUI SHEN, IDEPRO, ISUZU, JANATICS, JANOME, JU TENG INTERNATIONAL HOLDING, JUBAO, KAIFA INDUSTRIAL, KARMEN, KAWASAKI, KEISHIN, KITZ, KMUTNB, LG ELECTRONIC, LILI, LINNAN, MAITERUI, MAKITA, MATPLAST, MARKS, MAXWELL, MEIWA, MENNA, MICROENG, MIN CHANG METAL INDUSTRY, MINDA, MINGCHANG, MINGLIDA, MIRDC, MIZUTANI, MORIMOTO, NAKANIHON, NEMAK, NEMARK, NISSAN INDUSTRY, NISSIN SEIKI, OAK RIDGE NATIONAL LAB, OKUBO KANAGATE, PALOMA, PINGDONG INSTITUTE, QIANFENG MOLD, QINGLING, QINGMEI GROUP, QINGWEI, RAMCAR, RAMPRASAD, RONGHENG, RUILI, RUNXINTAI, RYOBI LTD, SAMSUNG, SAN CHAN METAL INDUSTRY, SANCAST, SANCHENGFENG, SANWA, SENSITIVE, SHANGDA, SHANGHAI JIAOTONG UNV., SHANGZHAN, SHENYUAN, SHIKOSEIKI, SHIMANO, SHINKO, SUN WAY WORLD MOLD, SUNDARAMCLAYTON, SYM MOTOR, TECHSENSE, TECNOSEAL, TEKNICAST, TEP ASIAN, TIANDING, TITANIA, TOKYO, TONGFENG MOLD, TSINGHUA UNIVERSITY, TWIN CITY DIE CASTINGS, UNIQUESHELL, UNIVERSAL, VARMA, VOLVO, WANHE, WENDA, WUYI, XIANG LIAN CASTING, YANGMING UNIVERSITY, YESHASWI, YIFENG METAL, YINBAOSANXING, YINDI, YOKOGAWA, YOUZHONG, YUNNAN INSTITUTE, ZHONGCHUAN ZIP



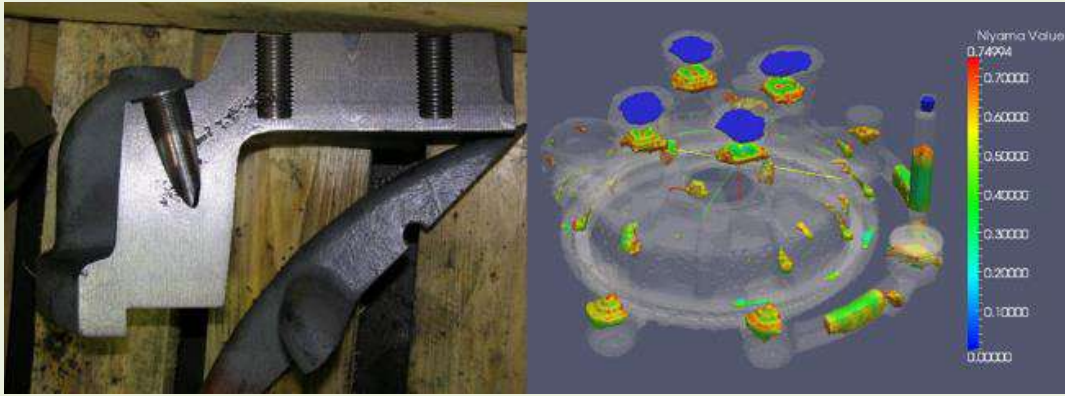
Air Entrapment



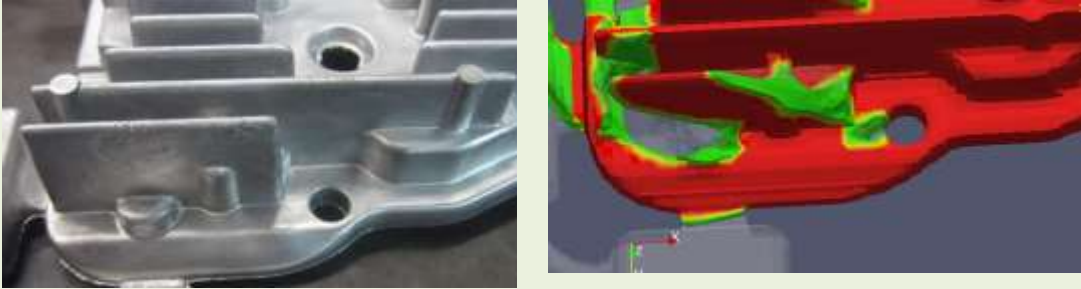
Unfilled region



Flow mark and surface quality



Shrinkage porosity



Cold shut and air entrapment

CUSTOMER TESTIMONIALS

Nicola Giardinelli, *Direzione Tecnica Bragonzi SPA*

I use **CAST-DESIGNER** form C3P, gravity casting with accurate results (steel and high Cr and high nickel cast iron). In the past I used it with centrifugal casting lost foam and I tried with high pressure die casting ... So for me it's a powerful software.

Technical Director, *Tongfeng mould, TAIWAN*

We used **CAST-DESIGNER** for a quite longer time and the accuracy of new generation CFD solver is really wonderful, we have solved lots of problems in such advance flow simulation. The optimization module is also quite affective and easy to use.

YANG Q., *General manager, Shenyuan Group*

CAST-DESIGNER acts as a specialist in our company for mould design and validation. We have never found any other software is so powerful and useful like **CAST-DESIGNER**. It can provide guideline to engineers directly, so it is not only help find the problem but also solve the problem.

CAST-DESIGNER MAJOR SOFTWARE PACKAGES AND MODULES

S/N	Cast-Designer Package & Module	Design package	CPI package	HPDC package	Gravity package
1	Cast-Designer framework	X	X	X	X
2	Gating system design	X	O	X	X
3	Free design of gating	X	O	X	X
4	Standard thermal and flow solver	O	X	X	X
5	Batch modeling & DOE optimization	O	X	X	X
6	Advance CFD solver	O	O	O	O
7	Stress solver	O	O	O	O
8	Microstructure solver	O	O	O	O
9	Parallel verison (CPU/Core depend)	O	O	O	O
10	Advance mesh assembly	O	O	O	O
11	Optimization (GA)	O	O	O	O
12	Geo-Design for DFM analysis	O	O	O	O
13	SavingCAST fro material charge	O	O	O	O

X: Available O: Option

Software language: English, Japanese, Chinese, Korean

SYSTEM REQUIREMENTS

SUPPORTED PLATFORM

- Windows / X86-64
 - Windows 11/10 /8 /7
 - Windows Server 2008/2012/2016/2019
- Linux / X86-64 (CentOS 7/8, RHEL 7/8, SUSE 15)

HARDWARE RECOMMENDATION

- CPU: Intel Core i7 process (minimum)
- CPU: Intel Xeon E5 processor (recommended)
- RAM: 8GB (minimum), 16 to 32 GB (recommended)

CAST-DESIGNER

SALIENT FEATURES

- Fast design for manufacturing (DFM) capability
- Fast upfront design validation tools
- Built-in gating system design capability
- Expert system based gating design advisor
- Tools for online design validation
- Automatic gating optimization capability
- Design of experiments (DOE) capability
- Powerful and fast assembly meshing capability
- Advanced CFD flow analysis
- Automatic optimization capability
- Mechanical & thermal stress and deformation
- Automatic deformation compensation solver
- Core blowing and core gas analysis
- Casting performance simulation
- Open system and highly customizable



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