CADMOULD & VARIMOS by SIMCON

AN INTRODUCTION

To the world’s best injection molding simulation and optimization solutions

Click here or scan the QR code to see our product video!

SIMCON

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Scan this QR code or click this link to get in touch with us!

Welcome to SIMCON!

We're delighted that you are interested in our software – in this brochure, we'll give you a more detailed look at what our many specialized modules do.

I'd especially like to highlight our optimization solution **VARIMOS,** which uses artificial intelligence to help great engineers to make the better decisions, faster. I think it could really make a difference for your engineering efficiency. This is because it **helps you automate** the tedious search for better alternatives in part, mold and process design. VARIMOS is not a replacement for a good engineer – it does require judgment and engineering expertise to really get the most value from it. But it makes great engineers better, by helping your team focus on the things that only a human can do – interpreting results, discussing options and making decisions collaboratively.

But before we dive in, we'd like to give you a brief **introduction to who we are** and what drives us, as a company – so that you know where we come from.

Optimizing Plastic Injection Molding, since 1982

At SIMCON, we've been helping world-leading innovators get better, faster and cheaper injection molding results since 1982 – and we're proud to say, we have an excellent customer retention. Once people discover what they can do with CADMOULD and VARIMOS, they stick with it. This is because our customers have come to rely on the speed, accuracy, and ease of use of our software, and the time, money and stress savings that result.

Our company began as a spin-off of one of the leading research institutes in the world, RWTH Aachen University's Institute for Plastics Processing (IKV). We are proud to say that we live and breathe the values of German engineering. Quality obsession, thoroughness, and a pragmatic will to get things done in practice are what drive us forward and keep us innovating. The fact that we're a company of engineers also really carries through in our support, which is run by deeply experienced practitioners, who have done thousands of projects. We'd be delighted to help you solve your challenges!

Your point of contact

You can find a list of our international resellers here, who offer local support internationally: https://www.simcon.com/reseller

If you have any questions or would like to discuss anything at all with us at SIMCON headquarters, we are happy to help. Please do not hesitate to reach out, and we will set up a video conference or phone call.

Sebastian Sutter
Head of International Business, SIMCON

My team and I manage SIMCON's international sales relations across the globe. I'd be glad to hear your questions and ideas. I will make sure to bring the best of SIMCON, and make sure our leading experts are involved when we address your specific needs.

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Plastic Injection Molding Simulation and Optimization Solutions

In this document, we'd like to introduce **CADMOULD**, the world's fastest plastic injection molding simulation software, and **VARIMOS**, our unique tool for automated optimization.

We'll cover the advantages, as well as the package structure and the modules contained in CADMOULD, covering their specific functionalities.

If you have any questions or would like to discuss how CADMOULD and VARIMOS can help your business, don't hesitate to **reach out today**!

OVERVIEW: OUR SOFTWARE MODULES AND PACKAGES

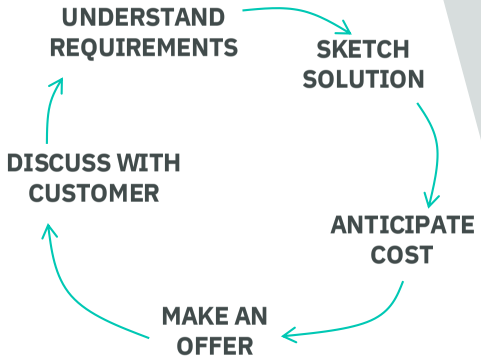
PACKAGES

MODULES	Starter		Professional		Premium
	FILL-IT!	WARP-IT!	OPTIMIZE-IT!	ENGINEER-IT!	VARIMIZE-IT!
Fill	✓	✓	✓	✓	✓
Batch	✓	✓	✓	✓	✓
Pack	○	✓	✓	✓	✓
Fiber	○	✓	✓	✓	✓
Warp	○	✓	✓	✓	✓
Cool	○	✓	✓	✓	✓
2K & Insert	○	✓	✓	✓	✓
Cascadic Injection	○	✓	✓	✓	✓
VARIMOS	○	○	✓	✓	✓
Unwarp	○	○	○	✓ (Choose 3 out of 6)	✓ (All 6)
3D T-Box	○	○	○	✓	✓
3D Structural FEM	○	○	○	✓	✓
Injection Compression	○	○	○	✓	✓
Foam	○	○	○	✓	✓
Rubber /Thermoset	○	○	○	✓	✓

In this brochure, we'll explain what these modules do, and introduce SIMCON as a solution partner.

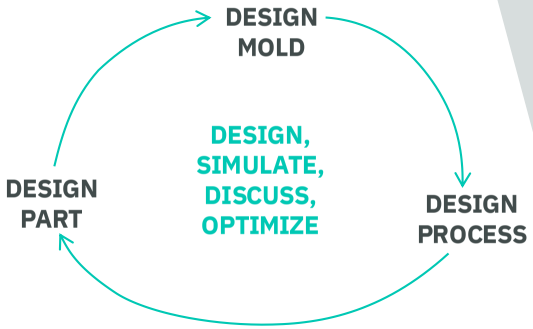
USE CASES FOR CADMOULD

WIN / ACQUIRE PROJECT



A. Quickly analyze **feasibility**
B. Fast, fact-based **part and mold costing**

DESIGN (VIRTUAL)

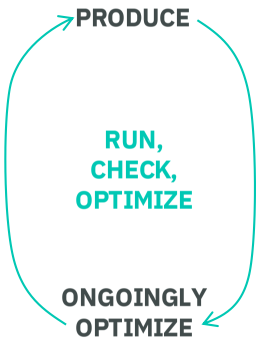


C. Optimize **part geometry** for injection molding
D. Choose the best **materials**
E. Design **gating** system (balance filling)
F. Optimize **filling**
G. Optimize **packing** phase
H. Design and optimize **cooling** system (hotspots, cycle time, etc.)
I. Design with **mechanical properties** in mind (FEM)
J. Optimize **process** parameters

TEST (REAL)

K. Shorter **sampling**
L. Increase the **first-time-right** rate ➔ fewer costly **correction loops**
M. Reduce sampling **material waste**
N. Continue to optimize **process parameters**

PRODUCE



O. Optimize **process parameters** for existing molds
P. Analyze **errors and defects** (find causes, for quality management)

Figure 1: CADMOULD and VARIMOS create value along the entire value chain.

WHY CADMOULD?

Fast

Due to our unique solver algorithm, which has been specially optimized for plastic injection molding, the simulation is extremely accurate and at the same time unrivaled in speed. This allows you to simulate more variants more quickly than with alternative, less efficient algorithms, and thus make better decisions.

Since the software is able to parallelize (multi) the computation of variants on multi-core systems, our speed advantage is compounded in DOE/optimizations and situations where you want to test many different options (such as when you use VARIMOS).

Automated Optimization

VARIMOS offers unique functionality in the field of injection moulding optimization. It uses artificial intelligence to automatically search for optimal solutions, saving you time and tedious repetitive manual work. It‘s a great way to make a good engineer faster and better, and help them focus on what counts: decision-making.

Flexible and Modular

The modular structure of the software makes it possible to tailor a package for your specific needs – no need to pay for what you don’t need.

If your needs evolve and you discover that you need additional functionality, you can simply expand CADMOULD’s functionality, by adding further modules.

Always Innovating

We continuously collaborate with research institutions, such as the Fraunhofer Institutes or the RWTH Aachen and leading partners from industry, to sharpen our toolkit and push the boundaries of what is technologically possible.

In collaboration with our customers, the results of this research flow into our products.

Accurate

Nothing is more important to us than the accuracy of our simulation. Our quality awareness is based on our guiding ideal of long-term partnership and our deep roots in the values of German engineering

Simulation is a representation of reality - and the requirements for accuracy and scope are constantly increasing.

Therefore, we continuously develop our algorithms and test them in extensive experiments by comparing real data at the machine with simulation results. In this way we ensure continuous improvement.

Simple

CADMOULDs has a simple and intuitive workflow. This makes it easy to learn the software and facilitates daily use. It won't take you long to become familiar with CADMOULD and get going in practice.

To get you started, we offer comprehensive, practice-oriented training courses, via video conference, in person, or for self-study in our Online Academy. And we offer webinars and specialized trainings for more advanced users.

Made in Germany, with Deep Expert Support

Our software development is headquartered in Germany, close to the research centers and the engineering talent that feeds our technological progress.

You need support? Get in touch with us at any time by e-mail, telephone, or via TeamViewer, which is integrated in CADMOULD.

The application engineers who run our support have years of experience with thousands of challenging injection molding projects, and will help you solve your challenges quickly and efficiently.

Compatible

The interfaces integrated in CADMOULD permit you to import a variety of leading CAD formats

CADMOULD also has the ability to export results as inputs to leading structural solvers.

VARIMOS: AUTOMATED OPTIMIZATION

VARIMOS is our **unique optimization solution** for plastic injection molding. It uses artificial intelligence to save you time and provide better results, by automating the search for optimal solutions.

How does VARIMOS work?

To get going, VARIMOS will ask you three things:

1) **What goals / quality measures** do you want to optimize?
2) **Which variables / parameters** may VARIMOS change, to achieve the goals?
3) **What restrictions** must not be violated?

Based on your answers, VARIMOS will create a **Design Of Experiments** for you, automatically **run these experiments** as simulations, create a **meta model** from the results, and **visualize** the results for you, simply and interactively.

Benefits

- **Automatically search the solution space** using artificial intelligence, instead of tedious and repetitive manual trial and error
- Test significantly **more parameter combinations** than can be tested manually
- **Identify optimal and creative solutions** that could not have been found by manual simulation
- **Work faster** and more efficiently
- **Unmatched speed and efficiency**, thanks to parallelization[1] of simulations and the highly efficient CADMOULD simulation algorithm
- **More substantiated and constructive discussions** with customers and colleagues. Have engineers focus on interpretation and decision making, rather than tedious repetitive work
- As a result, get a higher **first-time-right rate**, fewer correction loops, greater time savings and lower overall costs

[1] Parallelization requires the “Multi” license option. We strongly recommend this when using VARIMOS, as it gives you a decisive speed advantage.

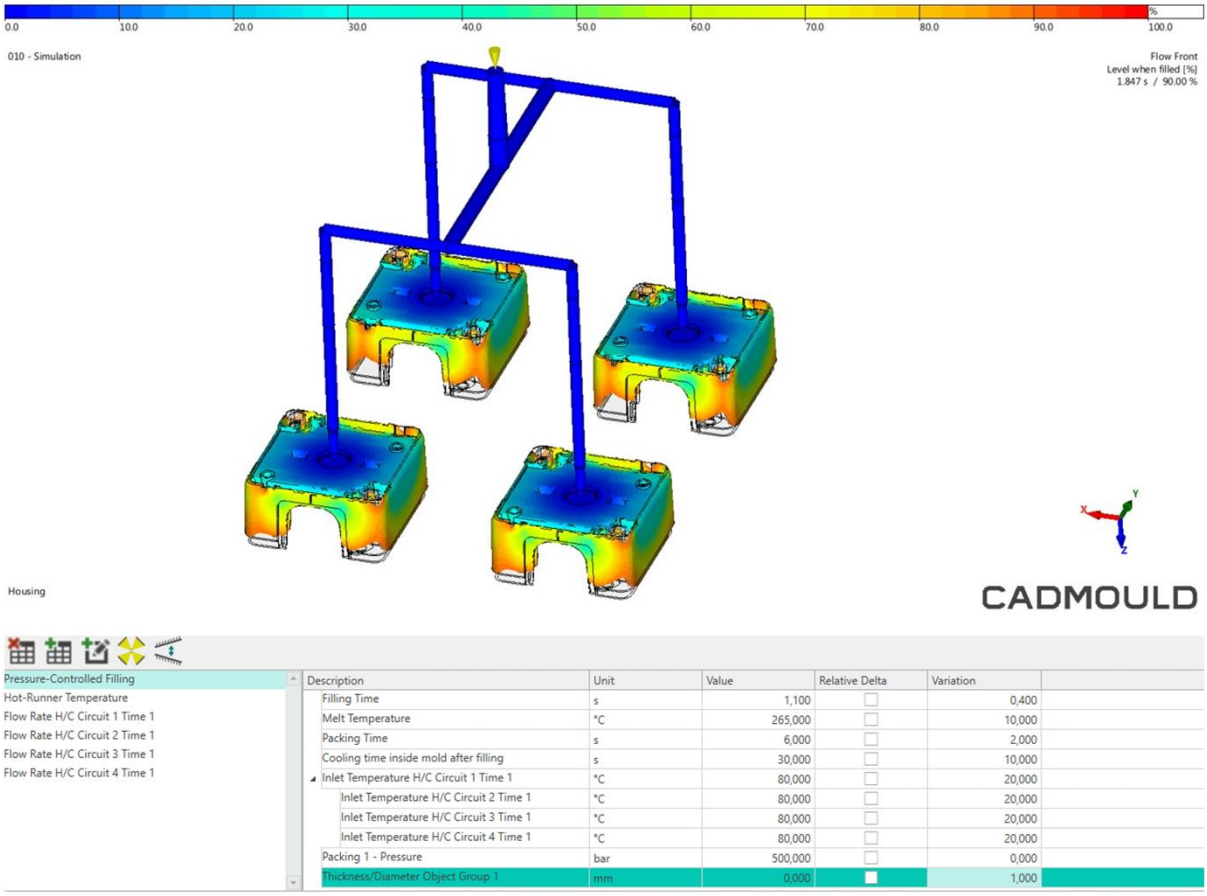


Figure 2: In this view, you can define what Varimos may vary (the variables). Variables can be, for example: Wall thicknesses of the component, process parameters such as pressure and temperature, cooling times, holding pressure times, etc. "Value" refers to the start value of a variable, "Variation" refers to a bandwidth that is laid plus/minus around the start value. This spans the experimental space for the respective variable. VARIMOS creates a test plan from this, simulates it automatically and finds the optimum values for the variables. VARIMOS also takes into account relationships between variables: for example, the different temperatures are not independent of each other and are therefore displayed in groups.

(1) Sensitivity

Sensitivity answers the question: How do the variables influence the goals or quality measures? You can interactively vary the variables with simple sliders and immediately see what changes in the results (see Figure 3). This allows you to see at first glance which variables are most important and which have only a minor influence on your results. This is useful for several reasons:

- **Check alternatives quickly – get more than a "point estimate"**
  Instead of getting only a "point estimate" of the set variables / parameters, as in a simple simulation, you can immediately **see how the results would change,** if the variable values were changed. The awesome thing about it is: you can actually manipulate the variables dynamically, and the results update dynamically, immediately. This makes it easy to see cause and effect relationships.

- **Recognize goal conflicts**
  Because you can immediately see the impact on quality characteristics when you change the variables, you can quickly check which goals are well matched and which are in conflict.
- **Better communicate and discuss with customers and colleagues**
  Because the presentation of the results is so simple and intuitive, you can discuss them with colleagues and customers quickly and easily, based on facts. Discuss which goals can actually be achieved at the same time and how you would like to prioritize when different goals conflict with each other.
- **Where can I save? Where can I not?**
  For example, variables that have only a minor impact can be designed to be particularly cost-effective. Variables that have a large influence should be examined more closely and, if necessary, should be examined in more detail during sampling.

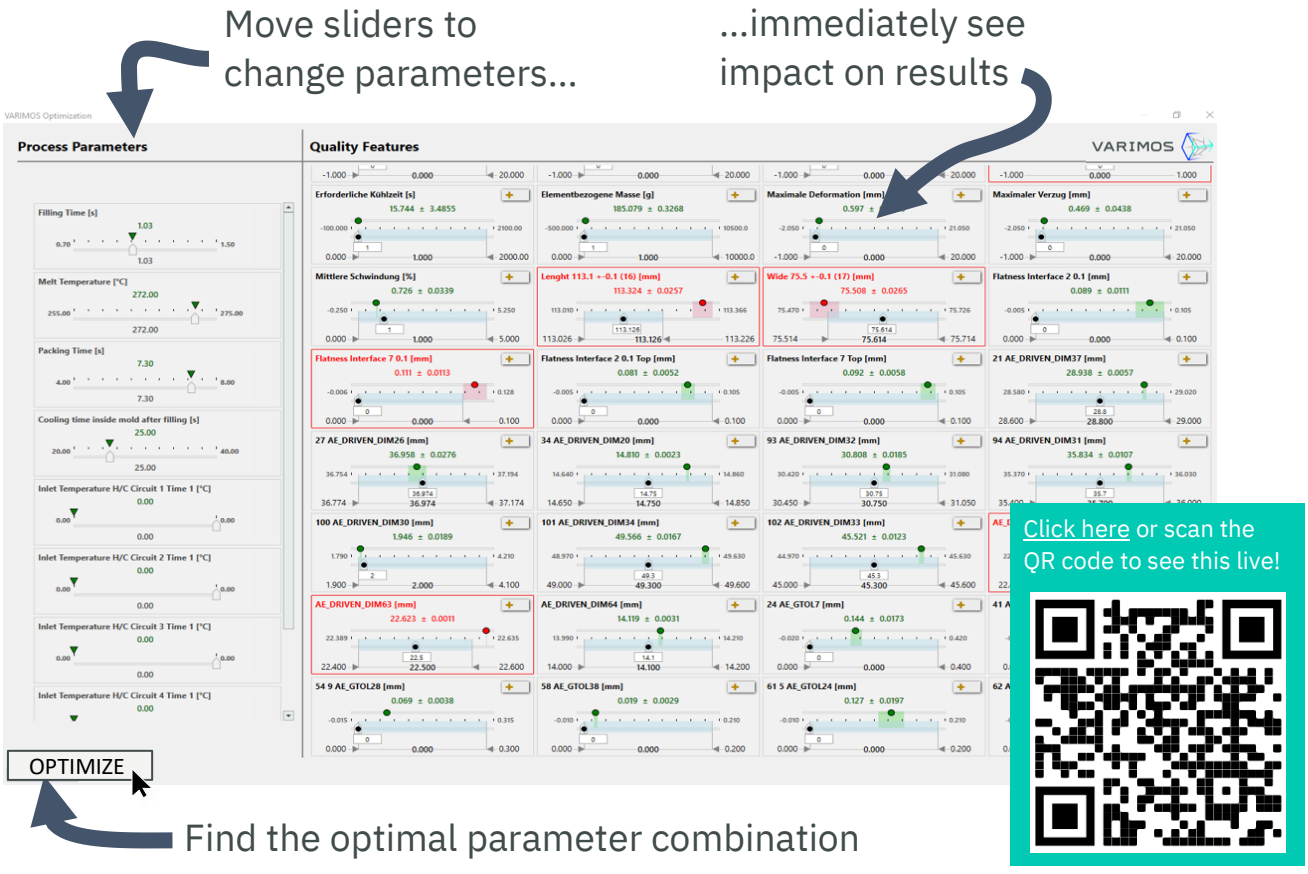


Figure 3: Display of results in VARIMOS. You can move the sliders of the variables on the left and see the influence on your quality measures or targets on the right. The optimal parameter settings are marked with green triangles on the left.

(2) Optimum

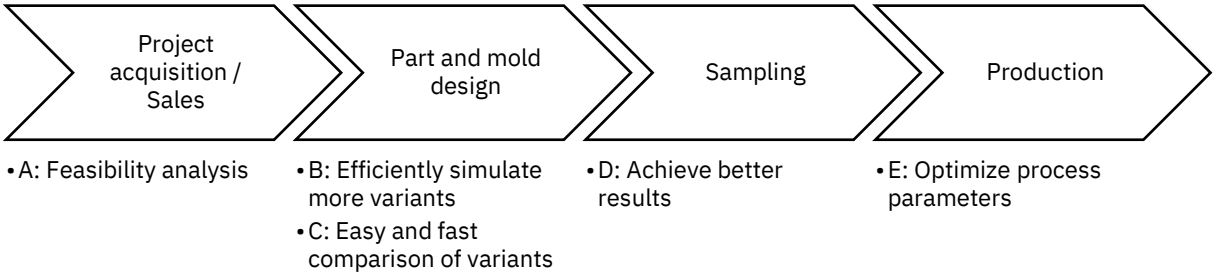
VARIMOS mathematically determines an optimal suggestion for improving component, tool and process parameters in order to optimally achieve your goals. The way this is designed has several advantages for you:

- **Unmatched speed**
  For an optimization, an experimental design is simulated through - this requires many simulations to thoroughly search the parameter space. This is where the unique speed advantage of CADMOULD as a simulation engine comes into play. Only CADMOULD offers the cutting-edge 3D-F algorithm, which is specially optimized for speed and precision in plastic injection molding. It combines speed with accuracy in a unique way. In addition, each individual simulation runs on a separate CPU core, so that the experimental design can be parallelized wonderfully during optimization. That way, VARIMOS can run several simulations simultaneously, each on its own processor core. On multi-core computers, this multiplies the speed advantage that CADMOULD already has at the individual simulation level. The result: Where conventional calculation methods may take days or weeks for a complex experimental design, CADMOULD and VARIMOS are often faster by a factor of 4-10 (depending on the component and computer configuration). CADMOULD's decisive speed advantage is what makes simulative optimization tractable in practice.
- **Systematic, automated analysis, instead of human trial and error**
  Instead of laboriously simulating various parameter combinations manually by trial and error, let VARIMOS' artificial intelligence do the repetitive work. This saves you valuable human engineering time and allows your team to concentrate on the really important points: interpreting the results and making decisions. You save yourself the repetitive, manual trial and error.
- **True optimum - finding unconventional solutions**
  With VARIMOS you can be confident that all important parameter combinations have been checked. Instead of simply stopping when you have a satisfactory simulation result, you can be sure that VARIMOS has systematically checked the entire solution space, and so that the result is not merely satisfactory, but truly optimal. This means that even unconventional solutions that you might not have tried by hand are investigated. Because no feasible option was left out, the solution will indeed be optimal. This certainty enables you to have fact-based discussions with colleagues and customers, and really zoom in on the tradeoffs that warrant discussion.
- **Flexibility with more than one goal**
  Of course, the optimum depends on how you weight different goals, relative to each other. You can set this weighting freely and dynamically, and also change it interactively, later on. The best thing is that you don't need to run any more

simulations if you've changed the weighting. Instead, VARIMOS will update on the fly and give you an adjusted optimum, usually within seconds.

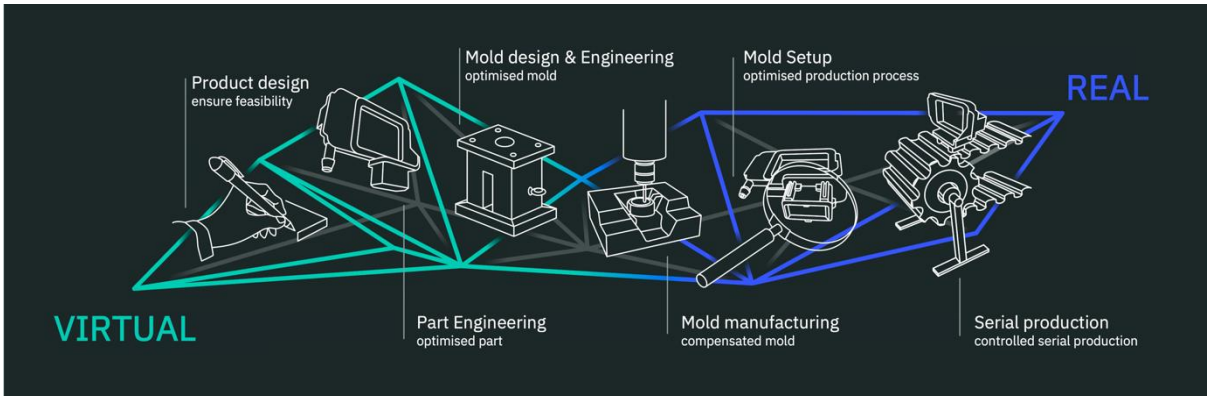
Use Cases

Our customers use VARIMOS along their entire value chain



A. **Analyze feasibility**, to check whether customer specifications can really be fulfilled at the same time. This allows you to give your customer fast, well-founded feedback and to make better calibrated offers
B. **Efficiently simulate more variants.** Don't just test your first hypothesis. Let the computer do the work and simulate variants around this solution. Your head remains free for more important things because you have automated repetitive work. Focus your energy on the important things: Interpret results, discuss options and make decisions
C. **Easy and fast comparison of variants.** See not only a "point result" but also variants. Check the sensitivity. What is really important? Discuss the advantages and disadvantages of different solution options with your customers
D. **Achieve better results,** be it in shrinkage and warpage, energy consumption, or other goals. You define the goals and VARIMOS will find solutions for you
E. **Optimize process parameters.** This is possible even if the mold is already built. At this stage, it is also possible to use the VARIMOS REAL product variant, which designs a sampling plan to be run physically, on the real machine, instead of using simulation to test variants (more on this in the next section)

Two flavors of VARIMOS



There are two variants of VARIMOS. Firstly, VARIMOS can be used in the **VIRTUAL** variant. Here, the design of experiments is executed in simulation, as described above. This variant is best suited if the mold has not yet been built so that the part and mold can be optimally designed from the start. Secondly, VARIMOS can also be used in the **REAL** variant. In this case the experimental design is not simulated, but physically carried out on the machine. This is suitable for optimizing the process parameters for existing tools or parts that are already in production, or to optimize the set-up process for new molds.

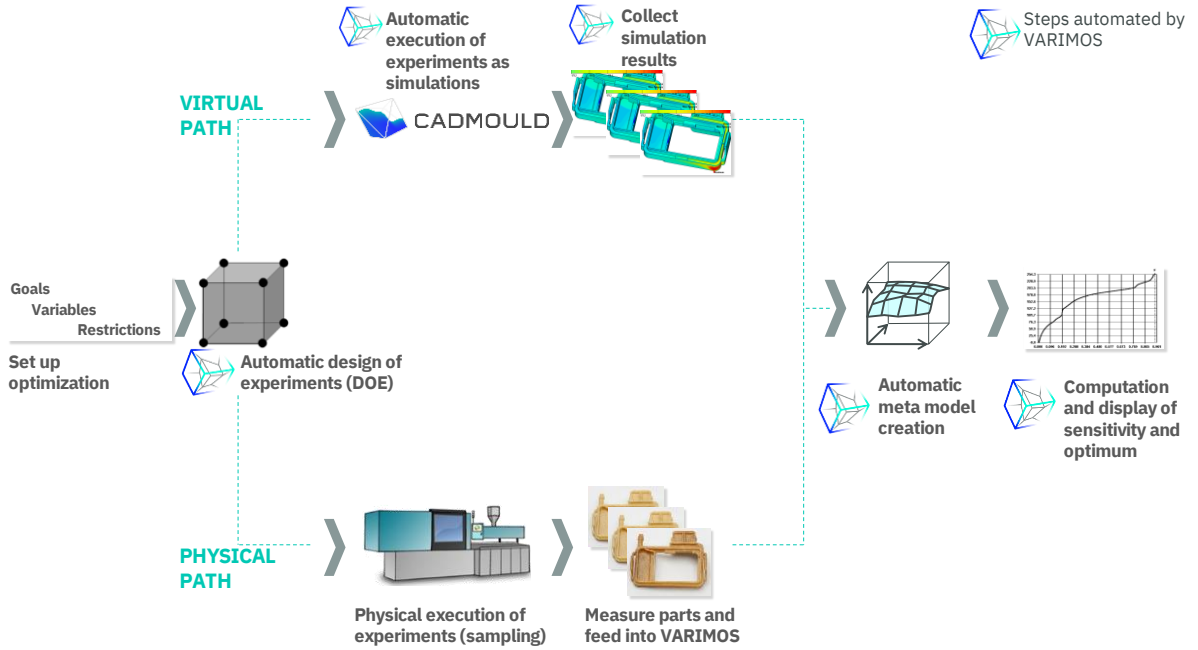


Figure 4: Two variants of VARIMOS. You can either use VARIMOS in the VIRTUAL variant (top path), or you can use it in the REAL variant (bottom path).

CADMOULD FILL

Core Functionality

CADMOULD Fill is our foundational module. It helps you to simulate the filling phase of your component, and calculates the results listed below, in detail. You can view these results in 3D, as a cross section, and as an animation across time.

- Filling of the part
- Pressure distribution
- Temperatures
- Flow speeds
- Clamping forces during filling (for clamping forces in the holding pressure and cooling phase, the Pack module is additionally required)
- Forces on sliders during filling
- Weld lines
- Air inclusions and venting
- Cooling time estimation and shot volume

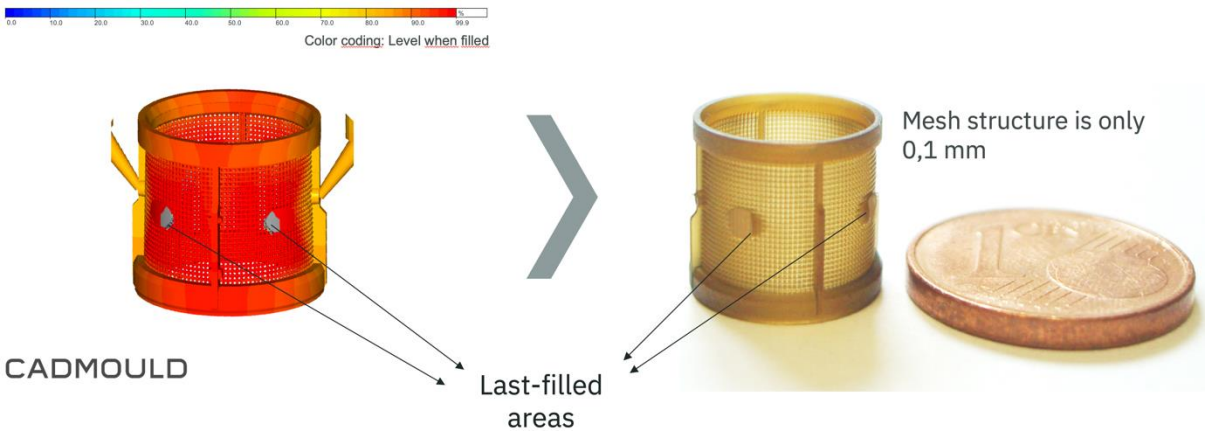


Figure 5: CADMOULD Fill was used to simulate filling of this filter, used in an ABS brake system for a car. CADMOULD was used to find the right places to put venting zones, in order to avoid filling issues in the filter mesh. The simulation proved extremely accurate, even for this extremely thin / fine part. The elements of the filter mesh have a diameter of 0,1 mm and less.

Benefits: What you can achieve using CADMOULD Fill

- Optimal design of the **part filling**
- Optimized design of **hot and cold runner** systems
- Determine suitable **gating positions** automatically, and balance **gating** systems
- **Adjust gating systems,** as well as part **wall thicknesses,** directly in CADMOULD, without needing to go back to CAD
- Design **multiple-cavity** molds
- Achieve a better **first-time right rate, reducing sampling time and material waste**, since the parameters of the filling phase are already known and optimized. Reduce costly mold corrections. This results in significant time and cost savings.
- The simulation results enable you to **discuss options**, **advantages and disadvantages** with your customers and colleagues

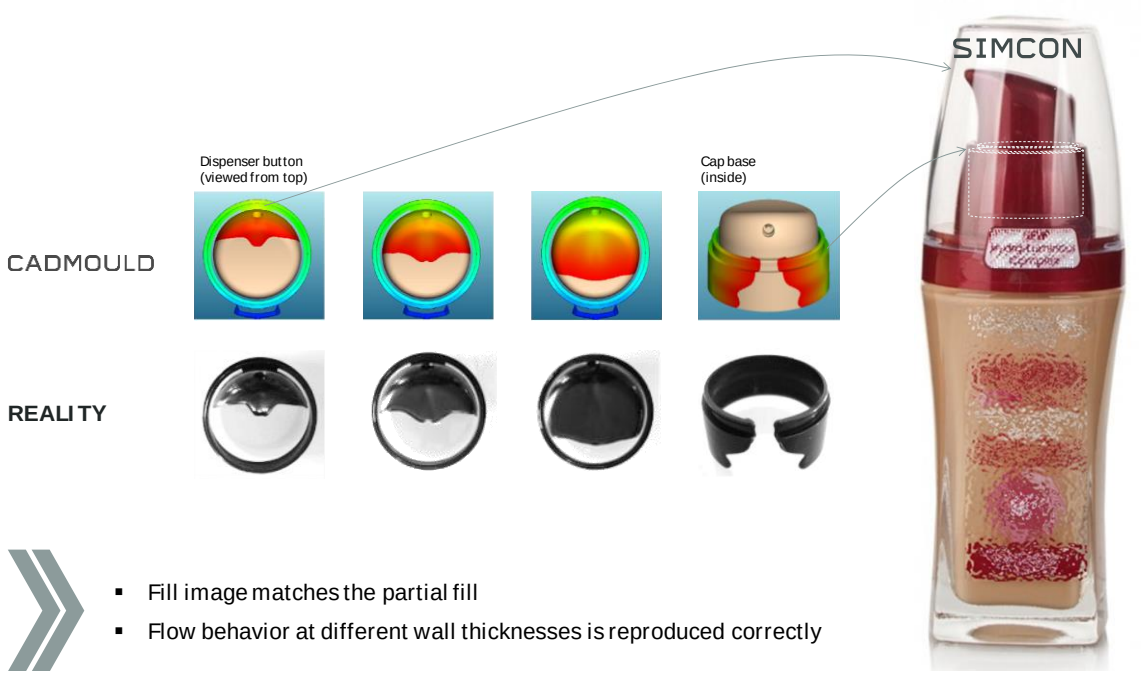


Figure 6: CADMOULD was used to simulate this cosmetics bottle spraying nozzle, for L'Oréal Paris. The challenge with this kind of part is that there is a variety of wall thicknesses. There is a very thin connection between the base of the cap, and the cap itself, and there are thicker parts before and after. The results show: filling behavior matched the partial fill perfectly.

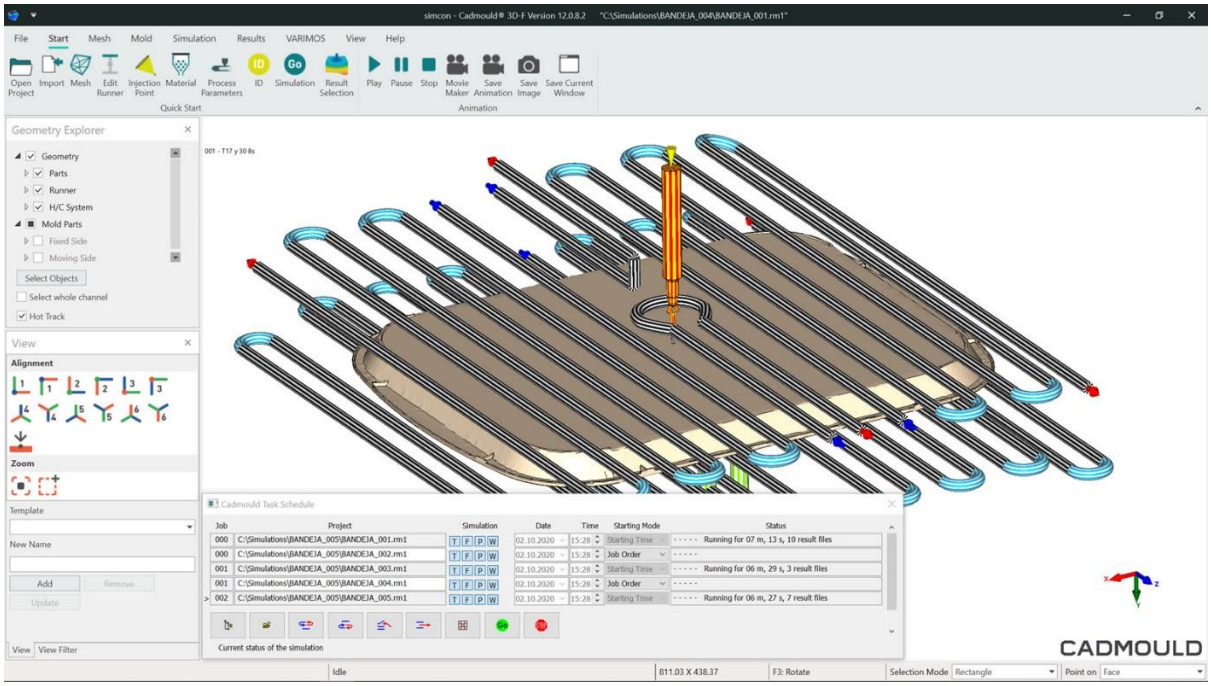
CADMOULD BATCH

Functionality

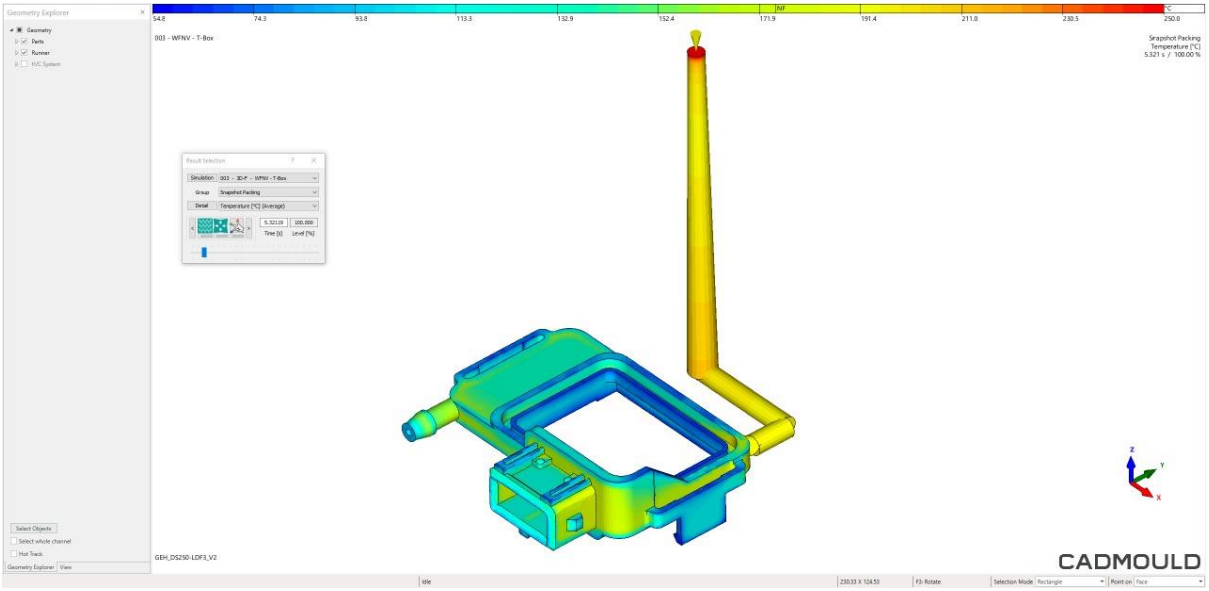
CADMOULD Batch allows you to run multiple simulations in batch mode while you can focus on other tasks. This means you don't need to trigger each simulation individually, but can "send off" several simulations at once. These are then automatically placed in the queue for the simulation calculation.

Usage

After setting up various simulations, you can prioritize them in a task list. After you trigger the first simulation calculation, all further simulation jobs are processed automatically, according to the defined list.

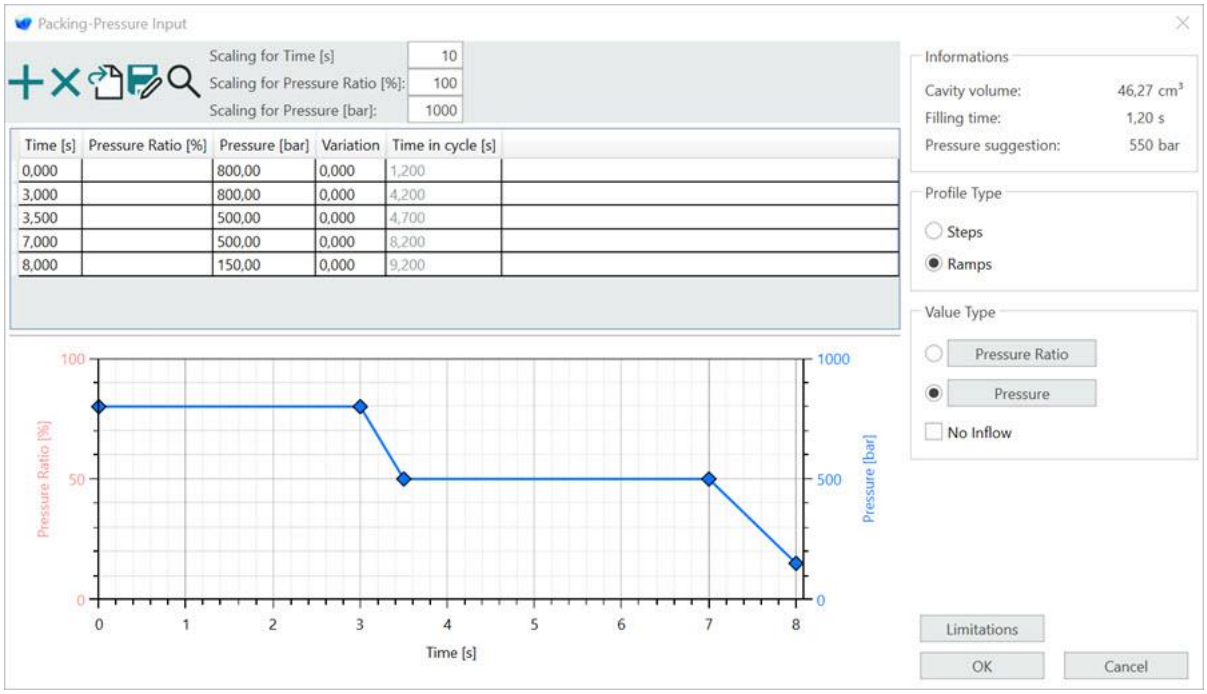


CADMOULD PACK



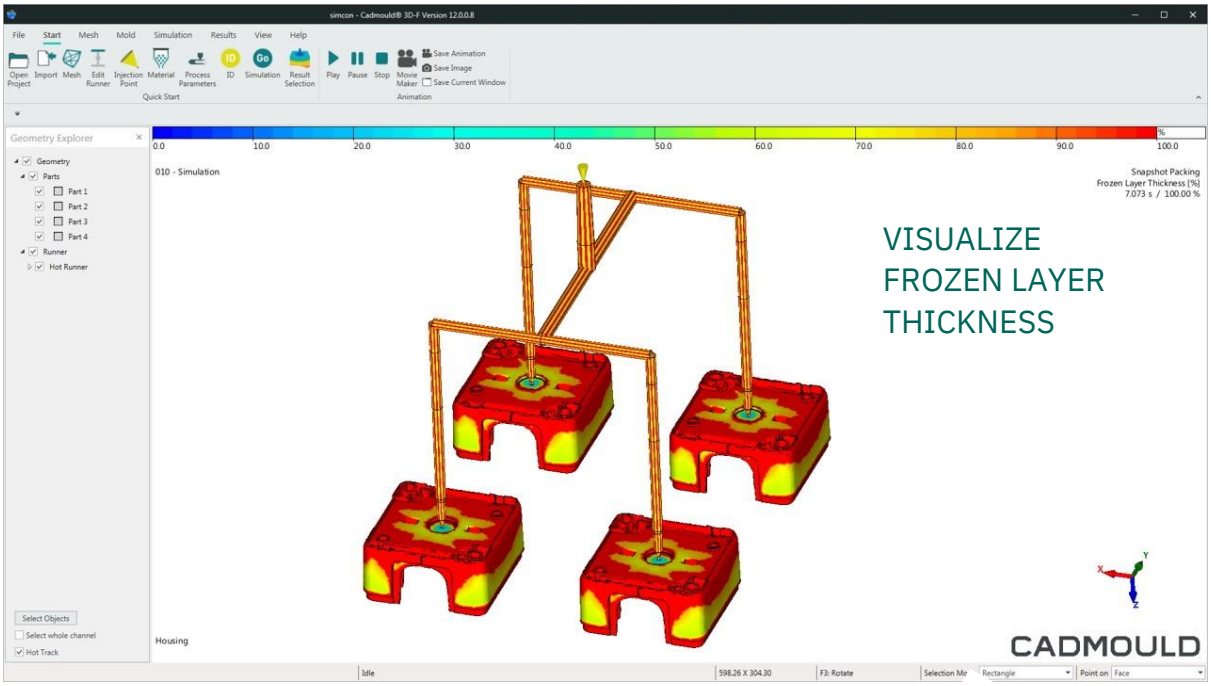
CADMOULD Pack enables simulation of the holding pressure and cooling phase of your component, building on the filling phase results from CADMOULD Fill. It computes the following results:

- Pressure distribution
- Temperatures
- Clamping forces
- Surface layer thickness
- Melt core in cross-section
- Volume shrinkage
- Thickness shrinkage / sink marks
- Cooling time and shot volume, incorporating the influence of the packing phase

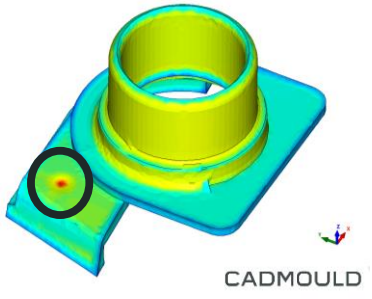


Benefits: What you can achieve using CADMOULD Pack

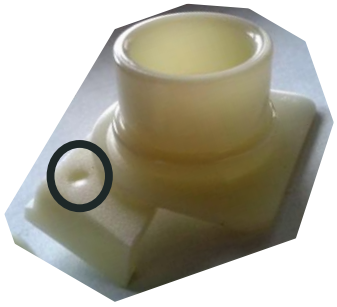
- Optimally specify **packing pressure, clamping force,** and **cooling phase** parameters
- Reliably determine **freezing, sealing and demolding** times
- Achieve **uniform volume shrinkage** distribution over the molded part
- Avoid **sink marks**
- Reduce **part warpage** through optimized shrinkage compensation (calculation of shrinkage and distortion results also requires the Warp module)
- Analyze temperatures and pressures to ensure **reliable demolding**
- Determine key data for **part and tool costing** by determining an optimized packing pressure and cooling phase with the software
- **Optimize existing processes** to achieve **shorter cycle times**, or in order to enable switching to a different injection molding machine



ACCURATELY ANTICIPATE SINK MARKS

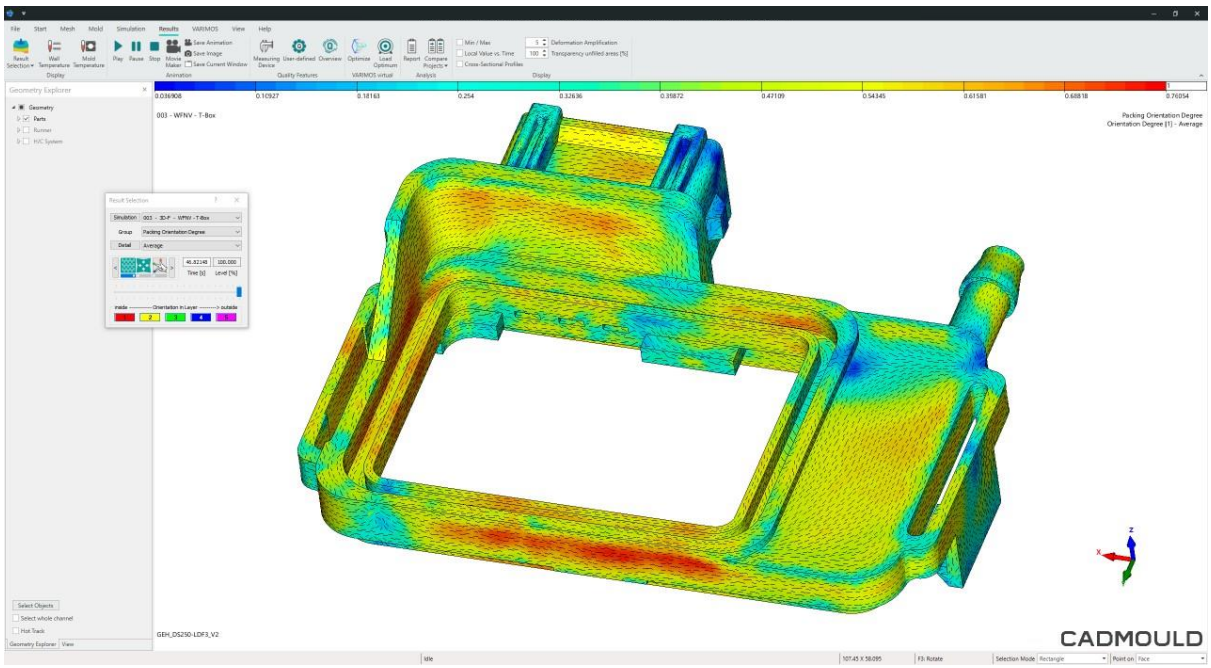


Simulated sink mark depth: **0,23 mm**



Measured sink mark depth: **0,25 mm**

CADMOULD FIBER



CADMOULD Fiber allows you to simulate the **fiber orientation** in your part. It calculates **detailed results** across time, and displays them averaged over the wall thickness, or in different layers:

- Fiber orientation direction
- Degree of fiber orientation

CADMOULD Fiber is an ideal complement to the Fill (simulation of filling), Pack (simulation of holding pressure and cooling phase) and Warp (simulation of shrinkage and warpage) modules.

Benefits

- **Precisely simulate fiber orientation** direction and degree of fiber orientation
- **Take into account fiber-related anisotropy** when computing shrinkage and warpage[2]
- **Solve warpage issues** through the analysis of fiber orientation. Warpage can then be reduced through optimized gating points, wall thicknesses and process parameters[2]
- **Export fiber orientation results** to other software, e.g. FEM structural solvers, crash testing simulations, or acoustic engineering applications

[2] In combination with Module “Warp”

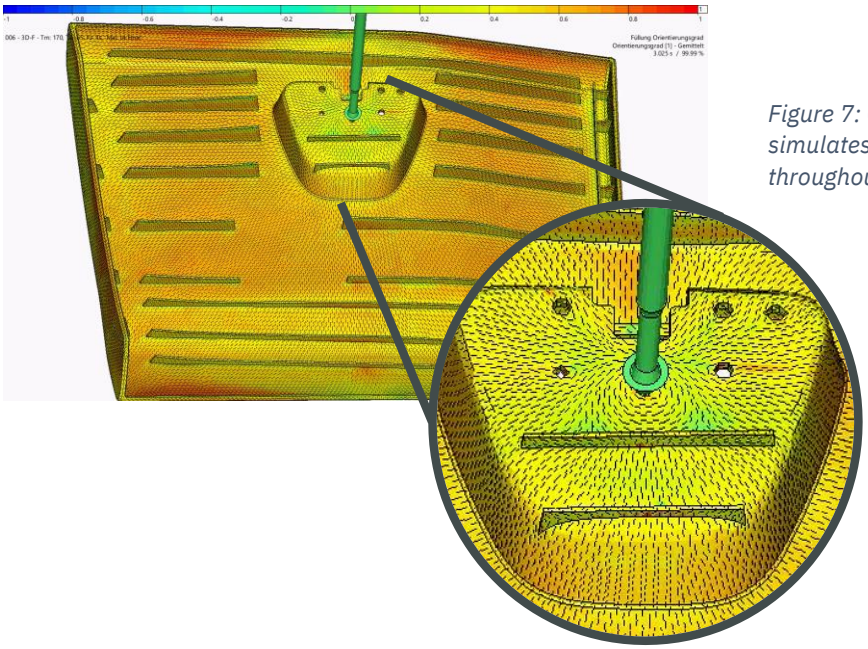
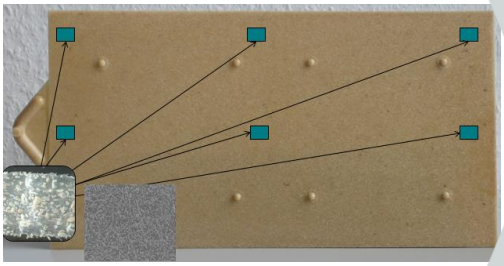


Figure 7: CADMOULD Fiber simulates fiber orientation throughout the filling process

WE USE CT SCANS TO VERIFY THE ACCURACY OF CADMOULD'S FIBER ORIENTATION SIMULATION

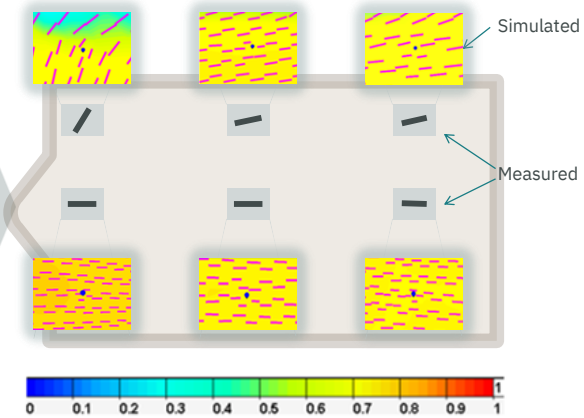
TEST DESIGN



- Physical test part used to verify accuracy of fiber simulation
- Principal orientation measured at 6 locations, in 7 layers, using CT, by Fraunhofer

Picture of sample part: Uni. Bremen, Müssig, Albrecht. Results: Fraunhofer-Institut für Holzforschung WKI, Prof. Endres.

RESULTS: SIMULATION VS REALITY



Principal fiber orientation, outermost layer

Figure 8: Our fiber orientation model has been calibrated through countless measurements, in research collaborations with Fraunhofer institutes and our industrial partners

CADMOULD HELPS ACCURATELY ANTICIPATE AND FIX FILLING ISSUES FOR NFC-REINFORCED MATERIALS

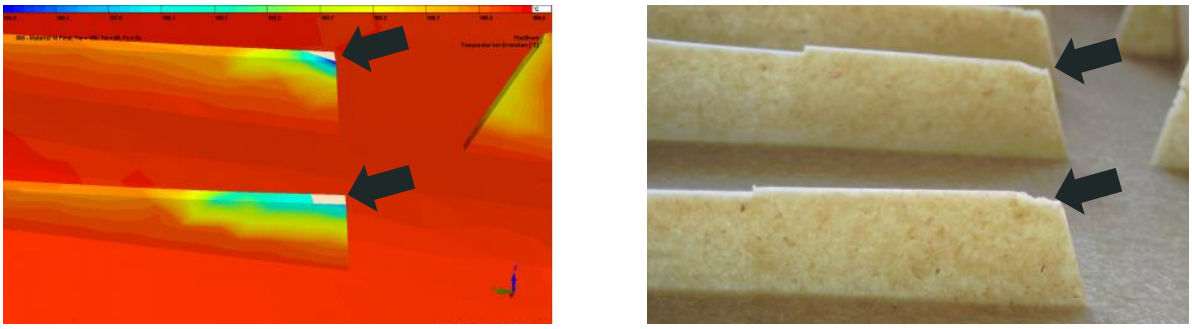
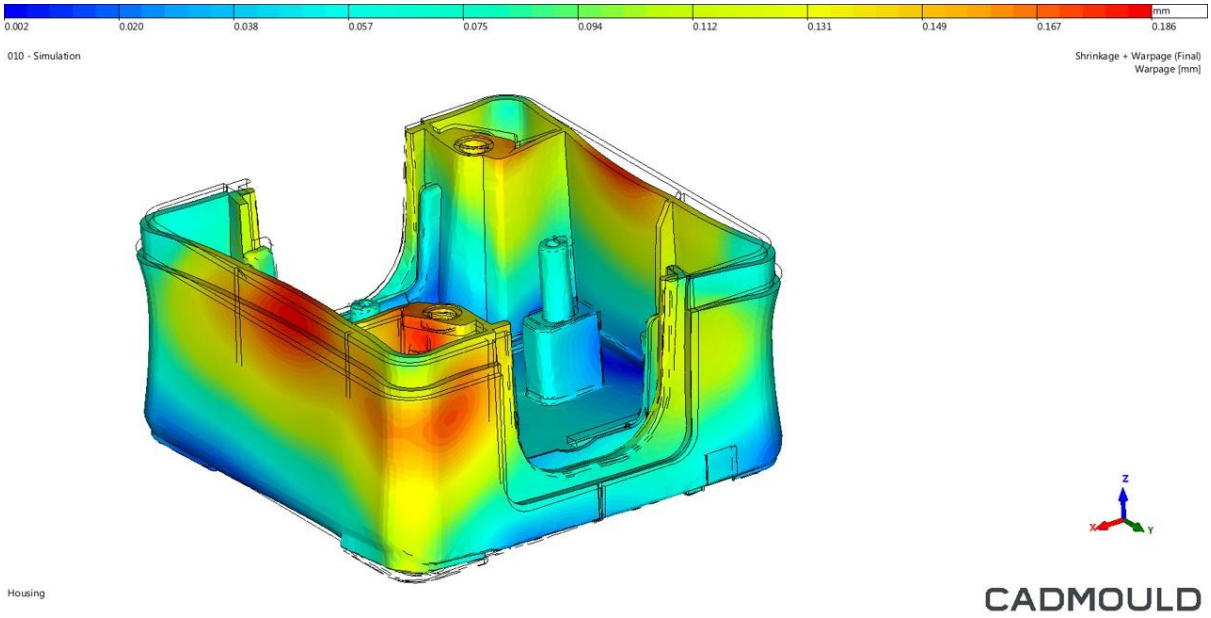


Figure 9: Accurate simulation of filling behavior for a fiber-reinforced material helps identify filling issues

CADMOULD WARP



CADMOULD Warp enables you to simulate **shrinkage and warpage** of any geometry. It computes the following results:

- Shrinkage
- Warpage
- Deformation
- Stress states (including frozen residual stresses)
- Temperatures after demolding

CADMOULD Warp is an ideal complement to the modules Fill (simulation of the filling phase), Fiber (fiber orientation) and Pack (simulation of the packing and cooling phase).

Benefits

- **Precisely anticipate** shrinkage and warpage
- **Solve warpage issues** by optimizing process parameters, adapting the mold design or changing wall thicknesses
- Use precise **virtual measurement tools**, to check compliance with dimensions
- Reduce sampling and waste, since warpage can be optimized beforehand
- As a result, better **first-time right** ratio and reduction of costly tool corrections. This results in significant time and cost savings
- The simulation results enable you to **discuss options**, advantages and disadvantages with your customers and colleagues

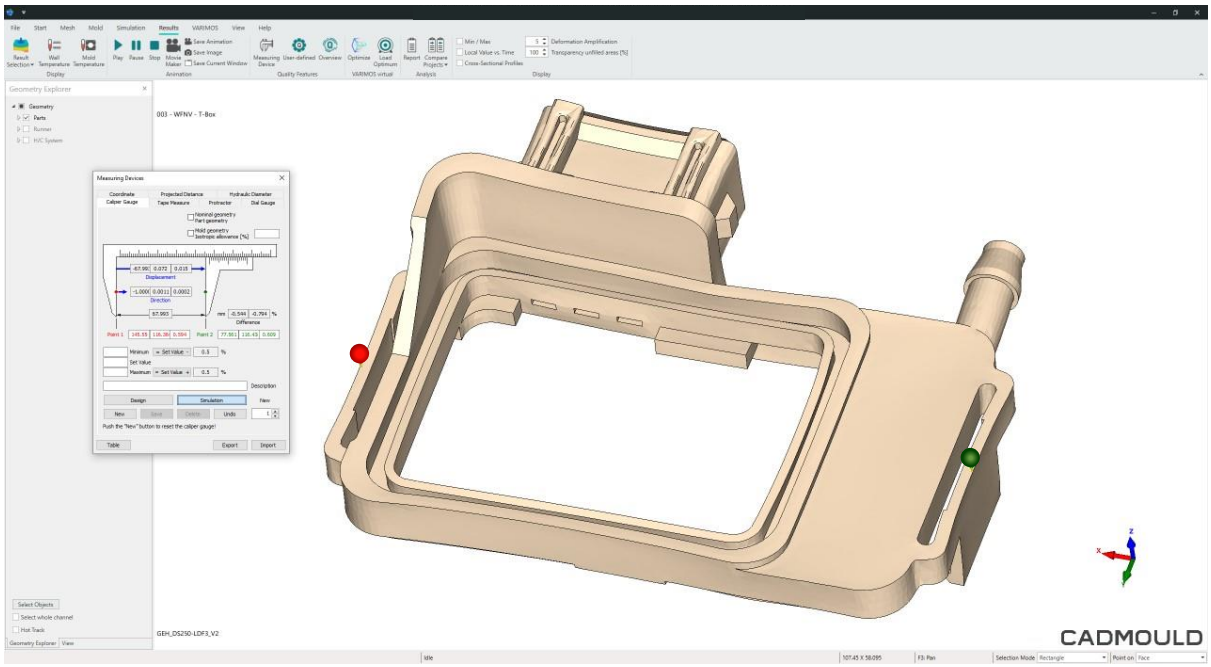


Figure 10: Virtual measurement tools help you to precisely quantify warpage along the dimensions that count. These measures can also be used as optimization targets in our optimization solution VARIMOS.

CADMOULD ACCURATELY SIMULATES SHRINKAGE & WARPAGE ALSO FOR NATURAL FIBER REINFORCED MATERIALS – THIS IS AN EXAMPLE FROM A PROJECT WITH FORD

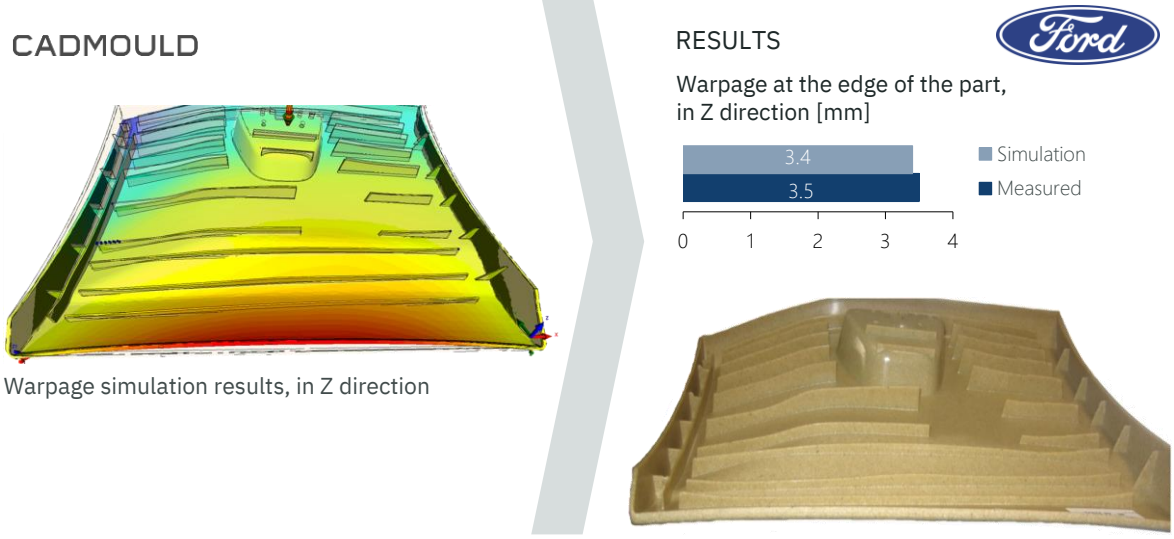
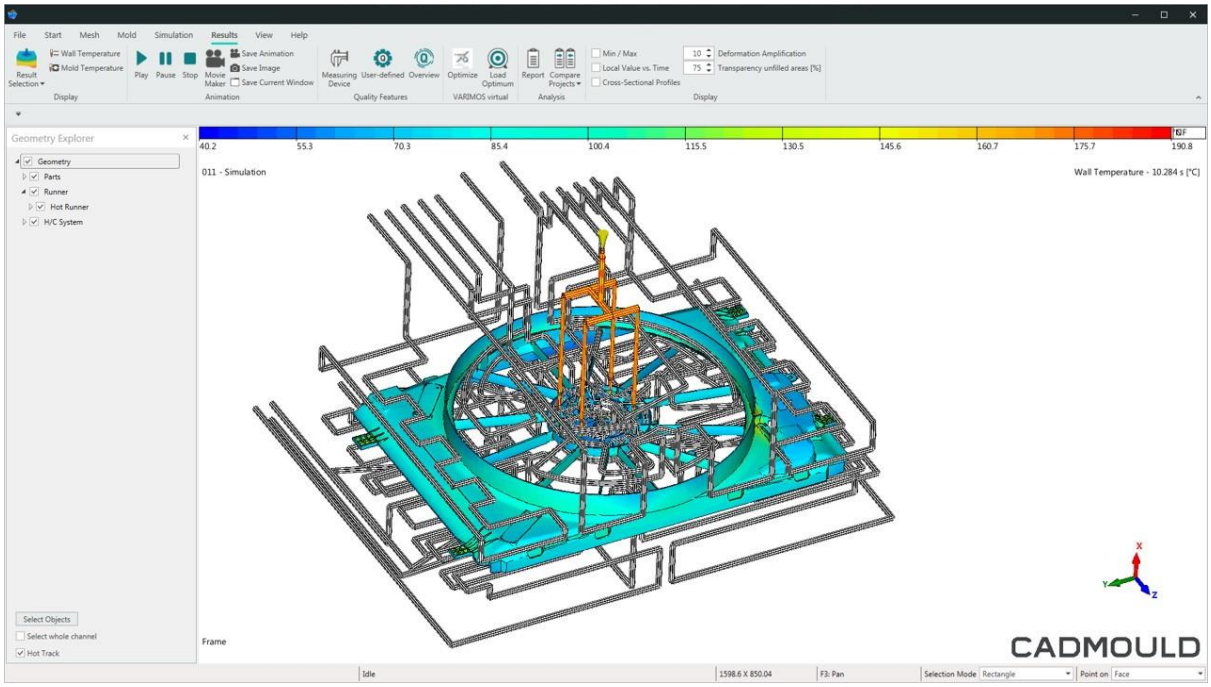


Figure 11: In combination with CADMOULD Fiber, CADMOULD Warp also takes fiber orientation into account. The accuracy of warpage results is shown here for the example of a glove compartment (top half), for a natural fiber reinforced material. Combining Warp with VARIMOS brings the additional benefit of being able to optimize warpage with automated methods.

CADMOULD COOL



CADMOULD Cool allows you to thermally design your mold and is the ideal complement to the Fill, Pack and Warp modules (simulation of filling, holding pressure and cooling phases, and of shrinkage and warpage). It computes detailed results concerning wall temperatures and the temperature control system:

- **Number of cycles** to the thermally stable state of the mold
- Local variation of **cavity wall temperatures** during the entire cycle
- **Flow rate and pressure loss** in the temperature control system
- **Temperature change** of the tempering medium
- **Turbulence** of the flow
- **Temperature control efficiency**
- Note: For full mold (as opposed to just cavity and cooling system) thermal simulation, also see our module **T-Box**

Benefits

- Optimal design of **wall temperatures** in the mold
- **Safe design** of temperature control systems
- **Reduced sampling** and less waste, as cooling times are already known and optimized
- **Design cooling systems**, without needing to go back to CAD
- **Detect and eliminate hot spots** due to mass accumulation or heat transfer processes in the mold
- **Optimize cooling systems** that are already in use, by determining optimal process parameters
- **Reduce cycle times** by optimizing the thermal system for the part and process
- Determine optimal **cooling times**
- As a result, better **first-time right** rate and reduction of costly mold corrections. This results in **significant time and cost savings**
- The simulation results enable you to **discuss** options, advantages and disadvantages with your customers and colleagues

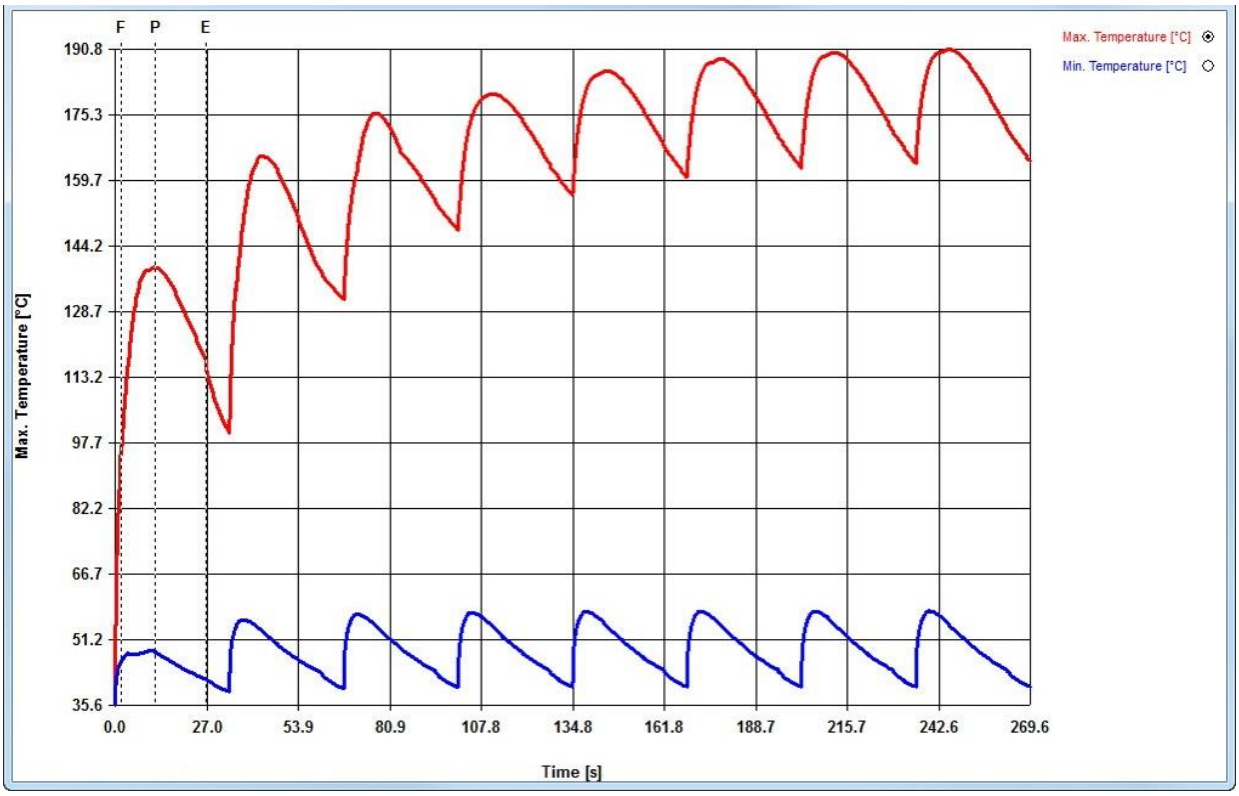


Figure 12: Example results of CADMOULD Cool: The evolution of maximum (red) and minimum (blue) wall temperature, across several cycles

CADMOULD T-BOX

CADMOULD T-Box enables the **thermal design of your mold**. For this purpose, the temperature control channels of the Cool module are combined with a complete calculation of the heat transfer processes **across the entire injection mold**. T-Box offers you two options:

1. By using an automatically generated mold sketch, consisting of temperature control, gating system and part, T-Box can be used right from the beginning of mold development
2. You can also use T-Box after completion of the mold design. In this case, T-Box simulates with the main mold components

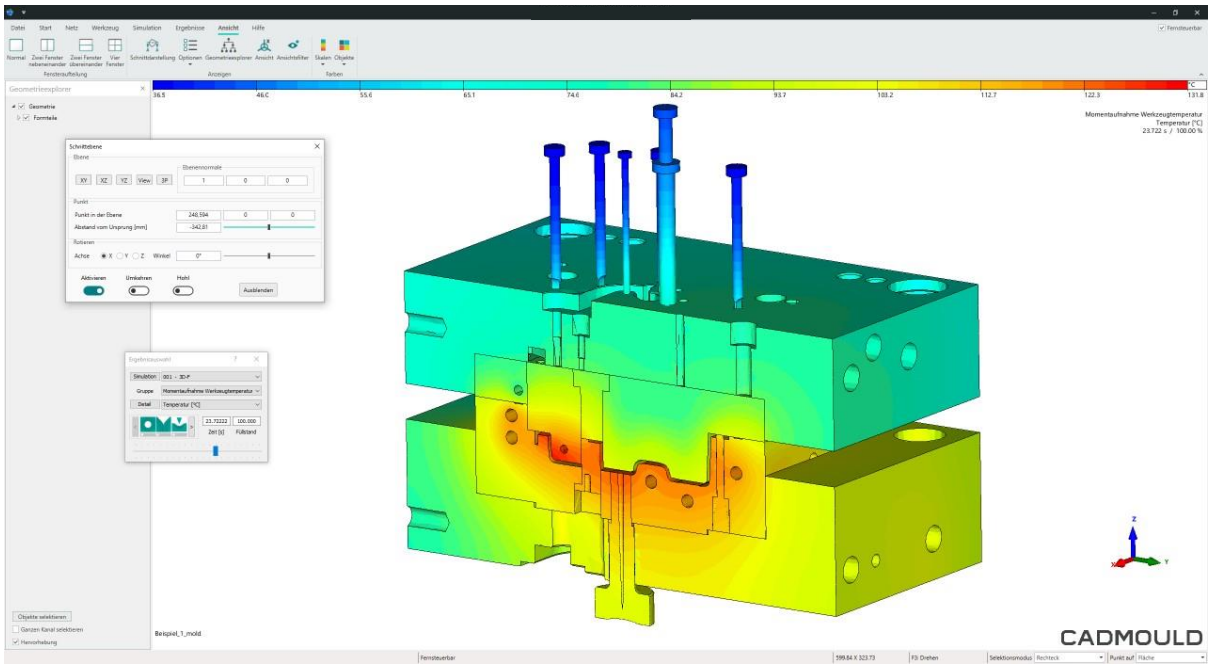


Figure 13: Temperature distribution along a cut through mold and part, at a specific time

T-Box computes the following results in three-dimensional detail:

- **Number of cycles** until the **thermally stable** state of the mold is reached
- Local variation of **cavity wall temperatures** during the entire cycle
- **Temperature distribution** and **heat flows** in the mold sketch or the simulated mold components
- **Flow rate** and **pressure loss** in the cooling system
- **Temperature change** of the tempering medium
- **Turbulence** of the flow
- Cooling efficiency

Benefits

- Determine cooling behavior for **optimal cavity wall temperatures**
- Determine **cooling time**
- Predict **temperatures and heat flows** in the mold
- **Detect and eliminate hot spots** due to use of different materials, mold separation or hot runner influence
- **Reduce warpage** through optimized tool inserts
- **Reduce cycle time** through mold inserts adapted to the part and the process
- Optimize existing cooling systems
- **Design molds** with confidence, with a better **first-time right** rate and fewer costly correction loops. Significant time and cost savings, and better discussions.

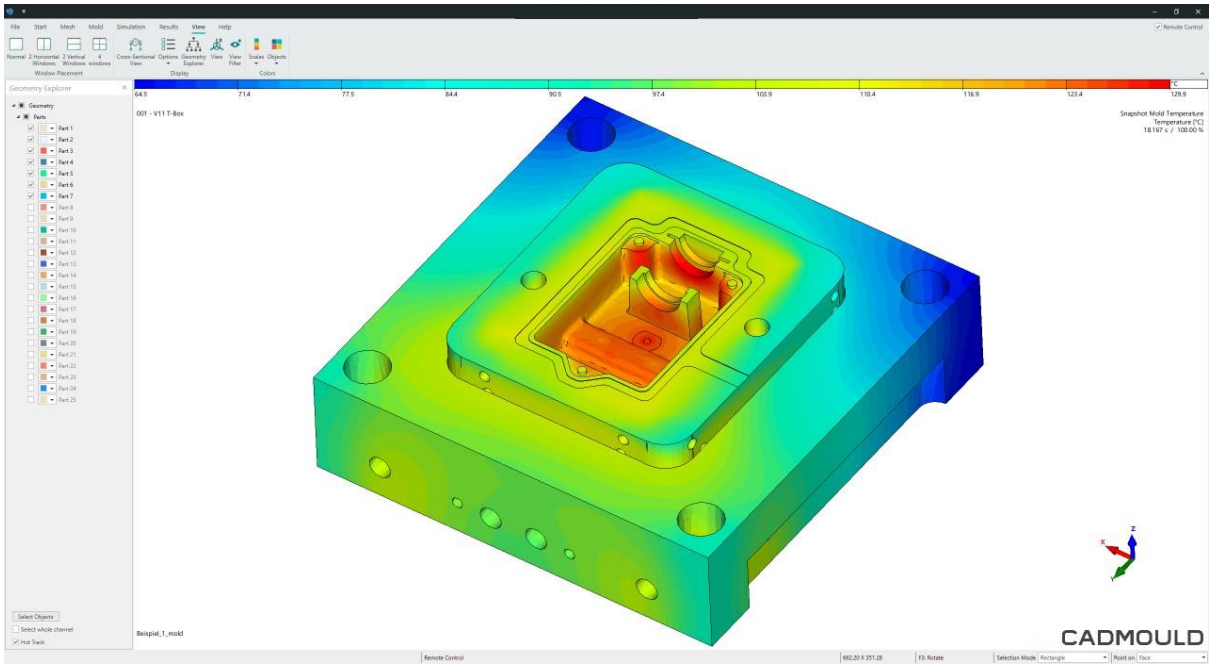
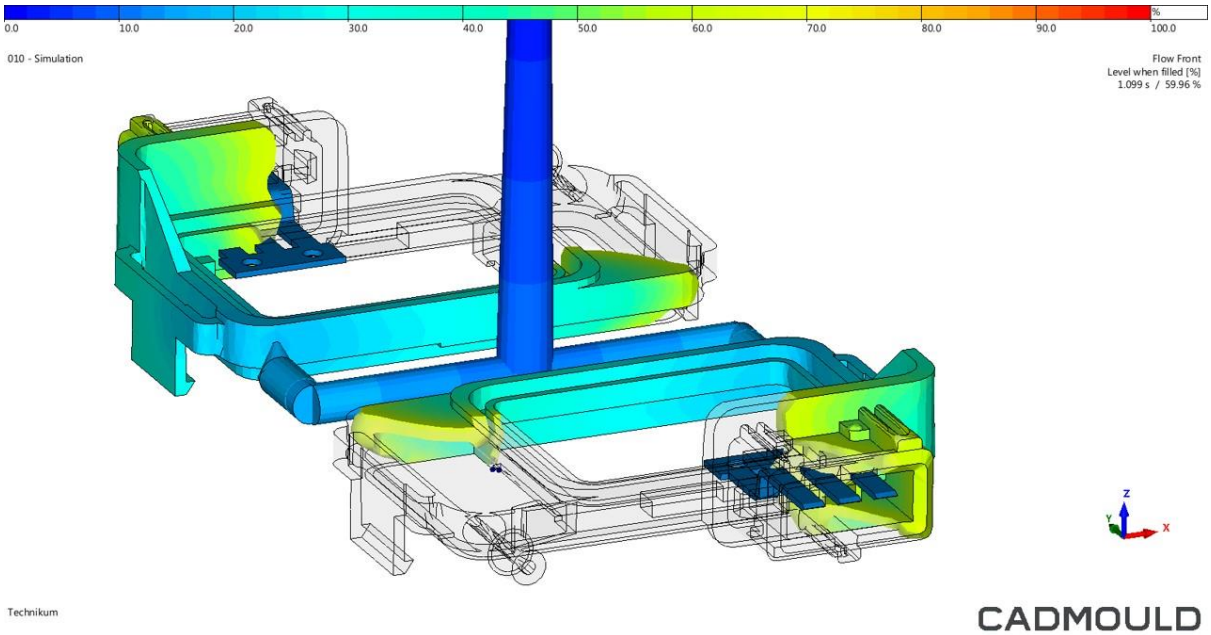


Figure 14: Snapshot of the mold surface temperature, in CADMOULD T-Box. In this example, the cavity is shown from above.

CADMOULD 2K & INSERT



CADMOULD 2K & Insert enables you to simulate **two-component and multi-component** parts. You can simulate parts that are produced by **sequentially injecting** different thermoplastics against each other, as well as parts with inserts made of **different materials (such as metal)**. If these are techniques you use, then 2K & Insert represents an ideal complement to the modules Fill (simulation of filling), Pack (simulation of packing pressure and cooling phase) and Warp (simulation of shrinkage and warpage). 2K & Insert computes the following results:

- **Filling** of the part (with multiple materials / with inserts)
- **Pressure** distribution
- **Temperatures** (also inside the components)
- **Flow speeds**
- **Deformation of inserts** or **core shift** during the injection phase (in combination with the Structural FEM module)[3]
- **Weld lines** and air inclusions
- **Freezing**, sealing and demolding time
- **Shrinkage**, for 2K or insert parts
- **Warpage**
- **Deformation**
- **Mechanical stress** (including frozen residual stresses)

[3] For more details, please refer to the Structural FEM module description.

Benefits

- Optimally design multi-component processes
- **Determine and optimize** the thermal and mechanical influence of individual components on the part
- **Detect and eliminate filling problems** in multi-component parts (air inclusions, weld lines, etc.)
- **Solve shrinkage and warpage** issues in multi-component parts
- Identify ways to **reduce the total warpage** of multi-component parts
- Specify **cycle times** and optimal preheating temperatures of inserts
- **Reduce sampling and waste**, since the process parameters are already known and optimized
- As a result, get a better **first-time right** rate and reduce costly mold corrections. This results in significant **time and cost savings**
- The simulation results enable you to **discuss options**, advantages and disadvantages with your customers and colleagues

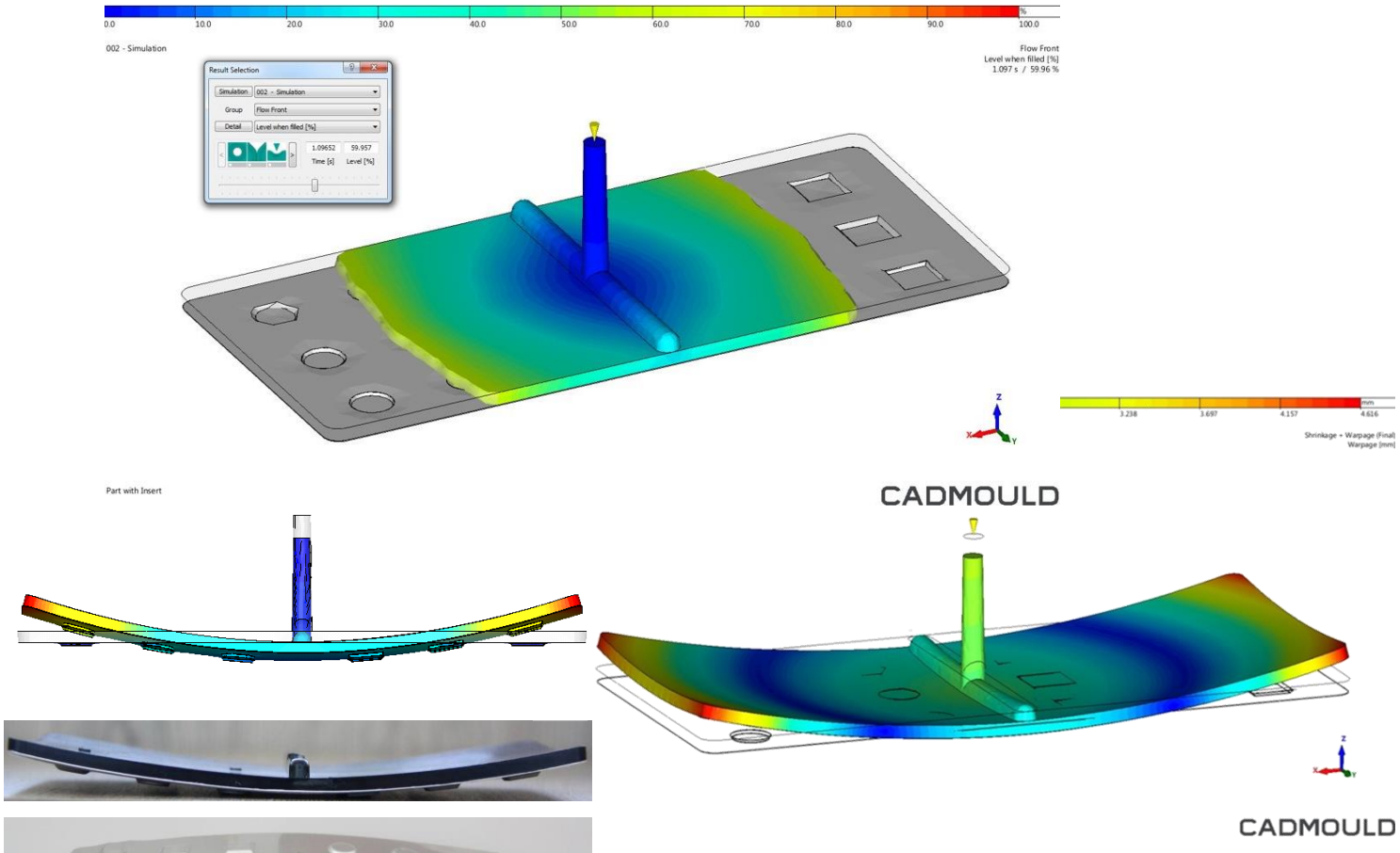


Figure 15: This part features a metallic insert. CADMOULD 2K & Insert, in combination with CADMOULD Warp, accurately simulates warpage for such parts.

Figure 16: CADMOULD was used to simulate the filling of this complex, thick-walled, multi-layered, multi-material car headlight lens. This project was undertaken with our partners at Fraunhofer, Hella and KrausMaffei. For optical parts, precision is crucial. The 3K filling of both macro structures and Fresnel-type microstructures was simulated accurately.

CADMOULD STRUCTURAL FEM

CADMOULD Structural FEM enables the simulation of a part's **mechanical behavior**, taking into account fiber-related anisotropies. The Structural FEM module is thus an ideal complement to the Fill (simulation of the filling), Pack (simulation of the holding pressure and cooling phase) and Fiber (simulation of fiber orientation) modules. In combination with the module 2K & Insert, **the deformation of inserts or the core offset** during the injection phase can be simulated. The following results are computed by the Structural FEM module:

- Deformation (displacement in space)
- Von Mises residual stress
- Elongation
- Strain energy density

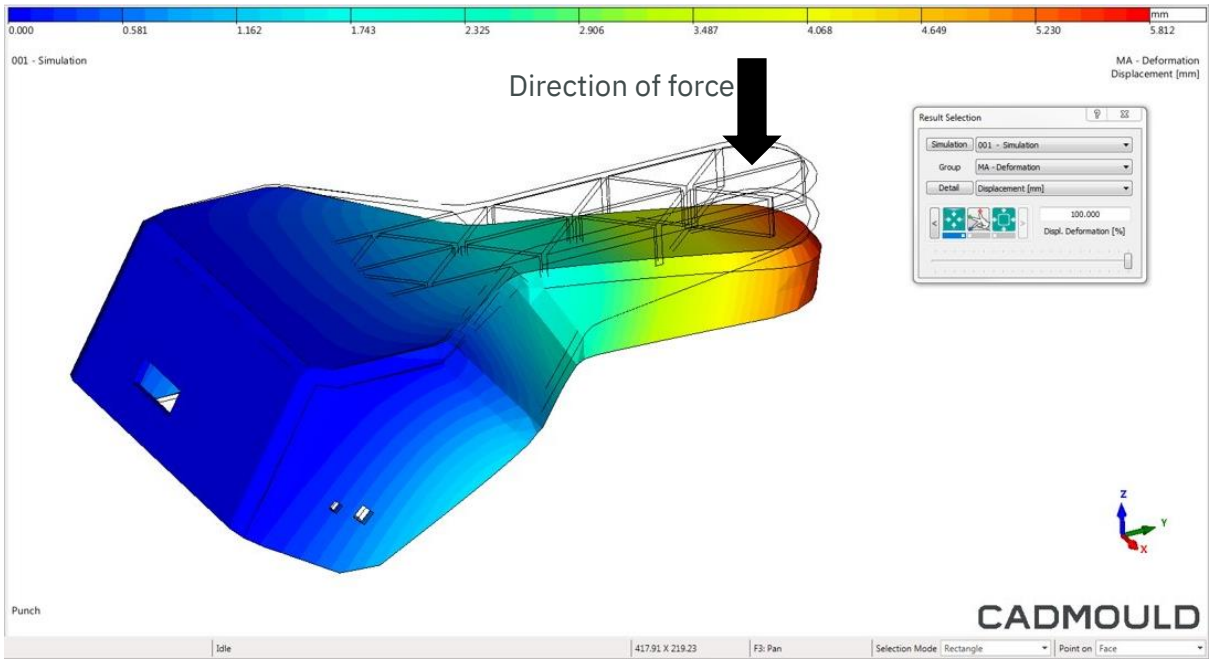


Figure 17: CADMOULD Structural FEM results display: MA - Deformation, displacement in mm. In this example, a force is applied to the part from above, deforming the part.

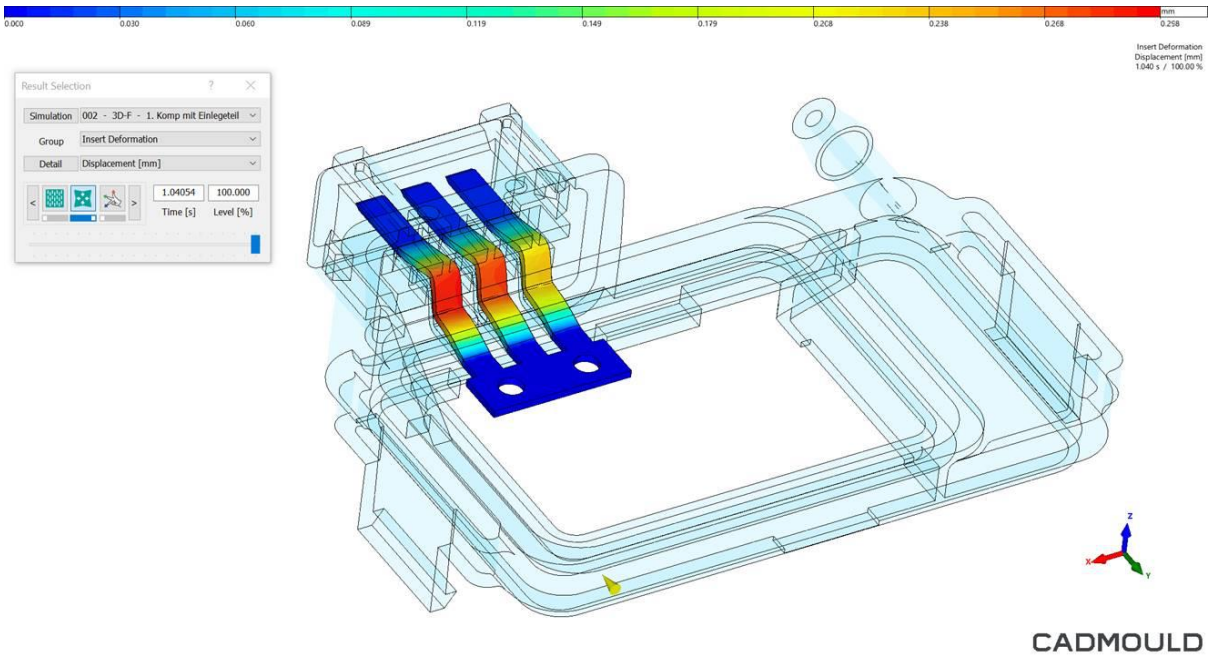
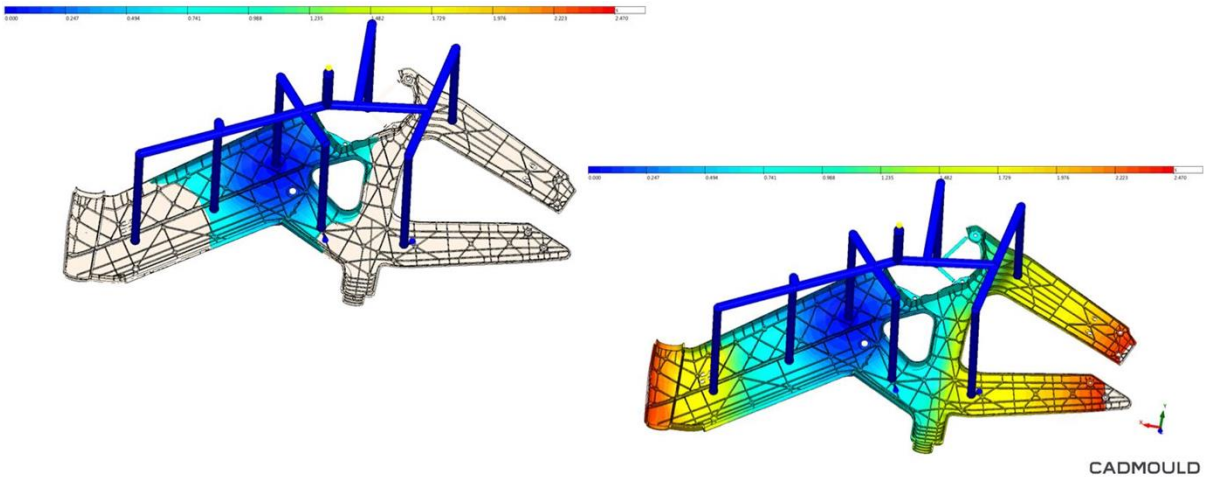


Figure 18: CADMOULD FEM: results display for insert deformation. The red zones are most significantly deformed relative to their intended position.

Benefits

- Improve engineering results by anticipating **mechanical component properties**
- **Select materials** that are compatible with expected stress and load
- Analyze the influence of **fiber orientation**, wall thickness and ribs on the mechanical properties of the part
- **Analyze part stability** and loads, once the part is built into a combined product
- **Reduce mechanical stress on inserts**, through optimized injection phase
- In combination with 2K & Insert: takes new **thicknesses due to insert deformation or core shift** into account for the filling behavior

CADMOULD CASCADIC INJECTION



CADMOULD Cascadic Injection enables you to simulate cascade injection molding, and computes the same key results as the core CADMOULD modules, but with the capability of simulating sequential filling across multiple gates:

- Filling (including weld lines and air enclosures)
- Pressure distribution
- Temperatures
- Flow speeds
- Clamping forces

CADMOULD Cascadic injection builds on CADMOULD Fill (filling simulation) and Pack (needed for packing pressure and cooling phase simulation).

Benefits

- Optimal design of **component filling** by cascade injection molding
- Determine optimal **cascade timing** and **gate switching** criteria
- Determine the **maximum injection pressure** and identify ways to reduce this pressure by modifying the gate control schedule
- **Compute packing and cooling phase results**, as influenced by the gate control. Anticipate shrinkage and warpage (requires modules Cool and Pack)
- **Anticipate and fix filling problems** such as air inclusions, weld lines, etc.
- **Rapidly and easily compare** alternative gate control schedules. Discuss advantages and disadvantages with your customers
- **Optimize process parameters for existing parts and molds,** to reduce the maximum injection pressure, to optimize weld line positions, and to minimize warpage

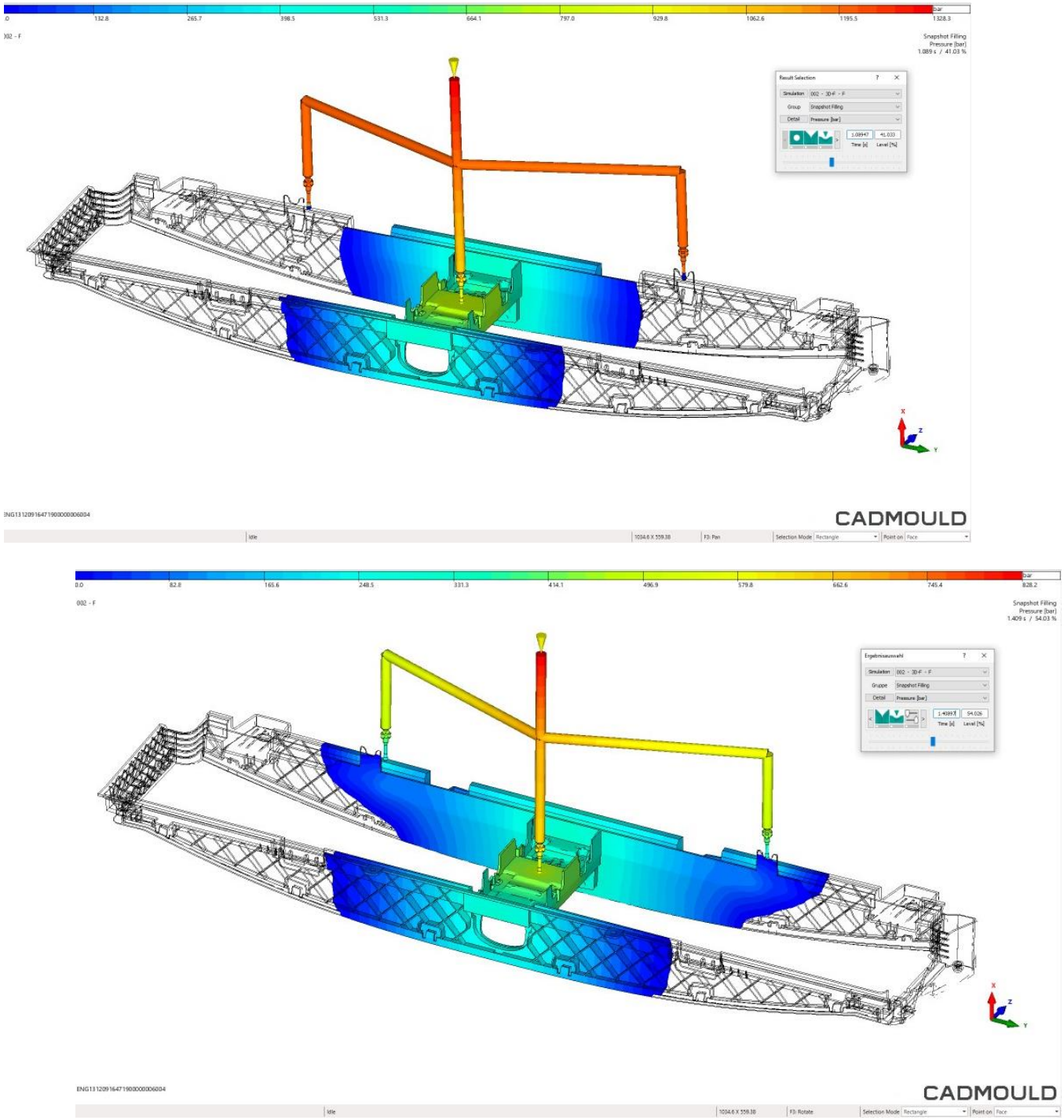


Figure 19: Filling behavior progressing across time in a CADMOULD Cascadic injection simulation. In the top picture, only the central gate is open. A bit later (lower picture), gates 2 and 3 have opened, after the melt front has passed their locations.

CADMOULD UNWARP

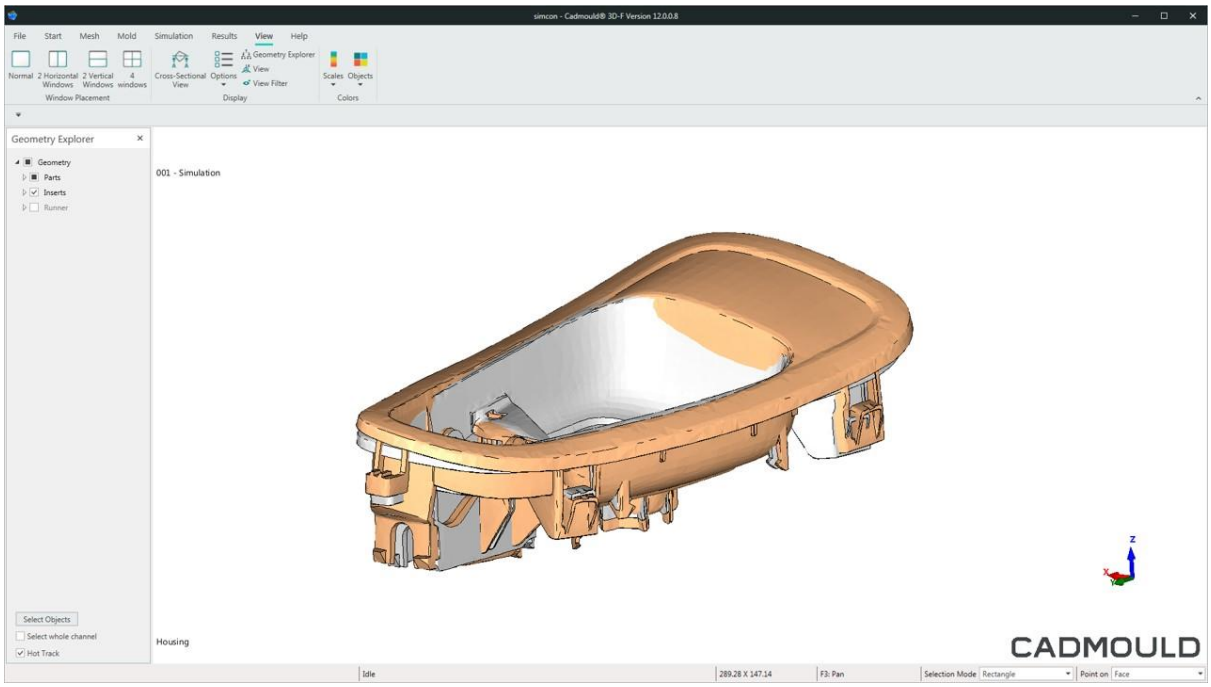


Figure 20: CADMOULD Unwarp displays the necessary mold compensation for shrinkage and warpage. The original part geometry is shown in grey. Orange areas signify compensated parts of the mold. The compensated mold can be exported in suitable CAD-compatible formats (tessellated, suitable for reverse engineering, see details below).

Results

CADMOULD Unwarp helps you to devise **mold corrections for warpage compensation**, in order to eliminate shrinkage and warpage. To achieve this, Unwarp uses the shrinkage and warpage results from the Warp module as inputs. The results that are computed include:

- Mold corrections for **shrinkage** compensation
- Mold corrections for **warpage** compensation
- **Deformation** corrections
- Deformed part **geometries**

Benefits

- Precise computation of **mold compensation**
- Maximum **dimensional accuracy** through optimal tooling
- **3D-print** physical representations of deformed component geometries, to assess dimensional compliance and compatibility with connecting parts
- Better **shrinkage and warpage results** from the start, because they have been compensated for adequately. As a result, better **first-time right** ratio and reduction of costly tool corrections.

- The ultimate result: significant **time and cost savings**, and an enhanced ability to **discuss options** and their advantages and disadvantages with your customers and colleagues

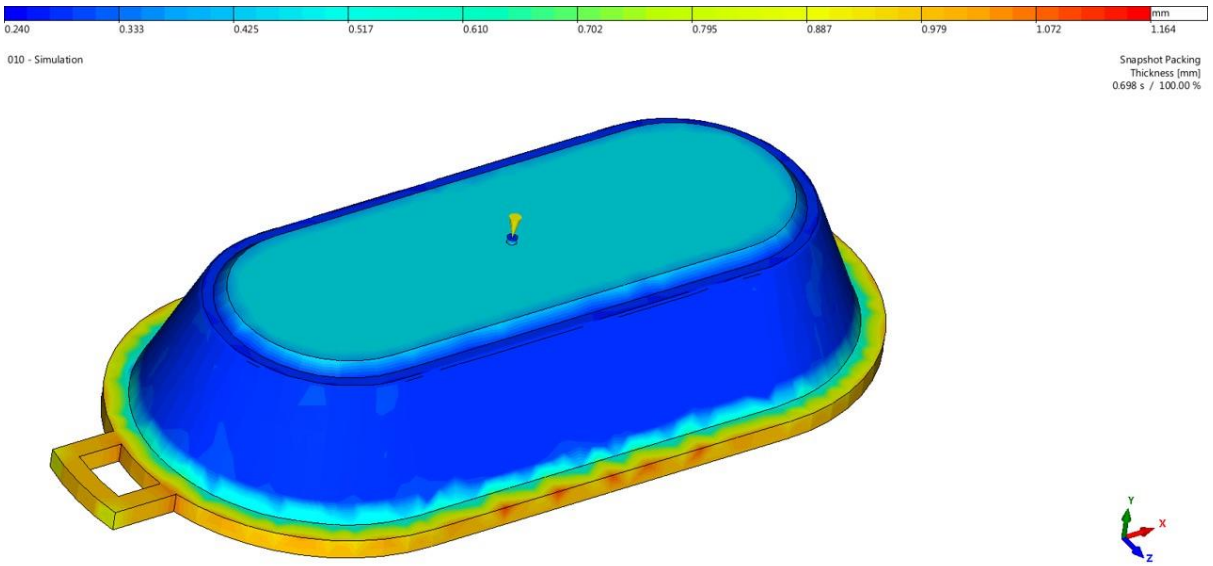
Formats

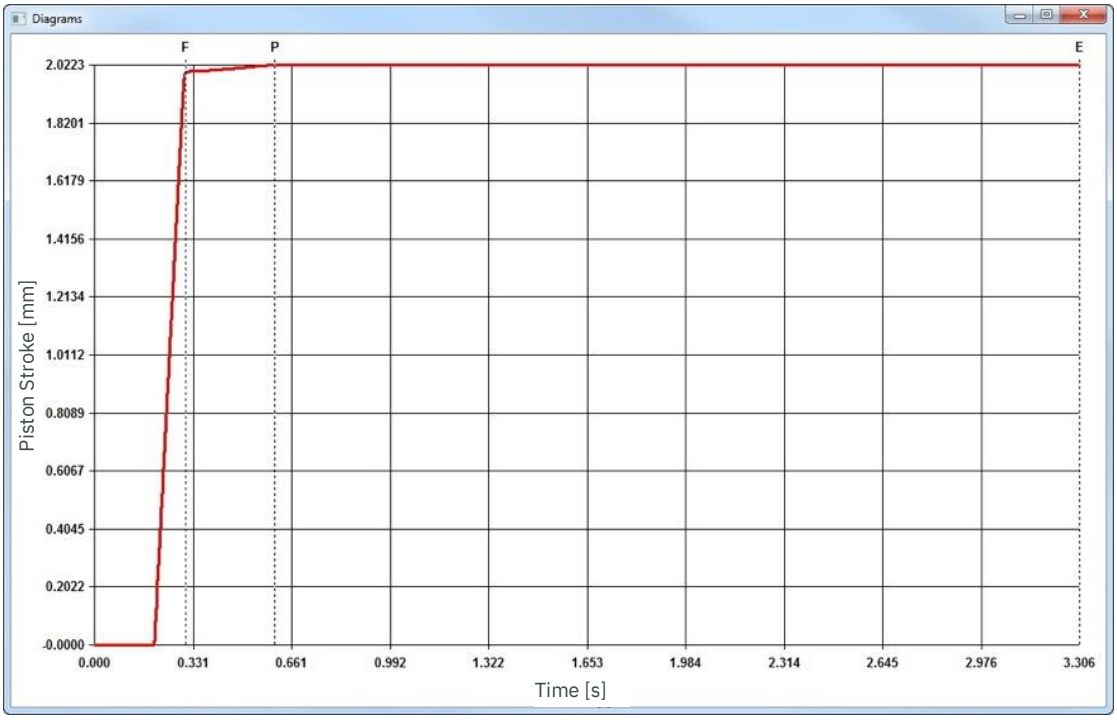
You can view the results in CADMOULD, and export the computed **warpage compensations**, as well as **deformed part geometries**, for further use elsewhere. The following output formats[4] are supported by our integrated export tool:

- STL (.stl)
- STEP (.stp / .step)
- IGES (.igs / .iges)
- Parasolid (.x_t / .xmt / .x_b / .xmt_txt)
- PRC (.prc)
- JT (.jt)
- UNIVERSAL3D (.u3d)
- VRML (.vrml)
- OBJEKT (.obj)
- COLLADA (.dae)
- Unwarp also enables you to create **text files with displacement vectors**, for example for working with CATIA® RSO®.
- In addition, it is also possible to view the geometries in **HTML** and **3D-PDF** formats.

[4] Export to CAD formats happens in tessellated form, suitable for reverse engineering.

CADMOULD INJECTION COMPRESSION





Results

Our specialized module for injection compression computes the core CADMOULD results, in settings where injection compression procedures are applied:

- **Filling**
- **Weld lines** and air enclosures
- **Pressure loss** and distribution
- **Temperatures**
- **Flow speeds**
- **Volume flow**
- **Clamping forces**
- **Stamping force** and speed
- **Shrinkage** and **warpage**

The injection compression module builds on CADMOULD Fill (filling simulation), Pack (packing pressure and cooling phase) and Warp (shrinkage and warpage).

Benefits

- Optimally **design** of the injection compression molding process
- Optimize the **filling and packing phase**, taking into account the compression movement of the mold
- Compute and optimize **stamping force and speed**
- Determine the right pressure and clamping forces
- Optimize the **stamping movement** of the mold

CADMOULD FOAM

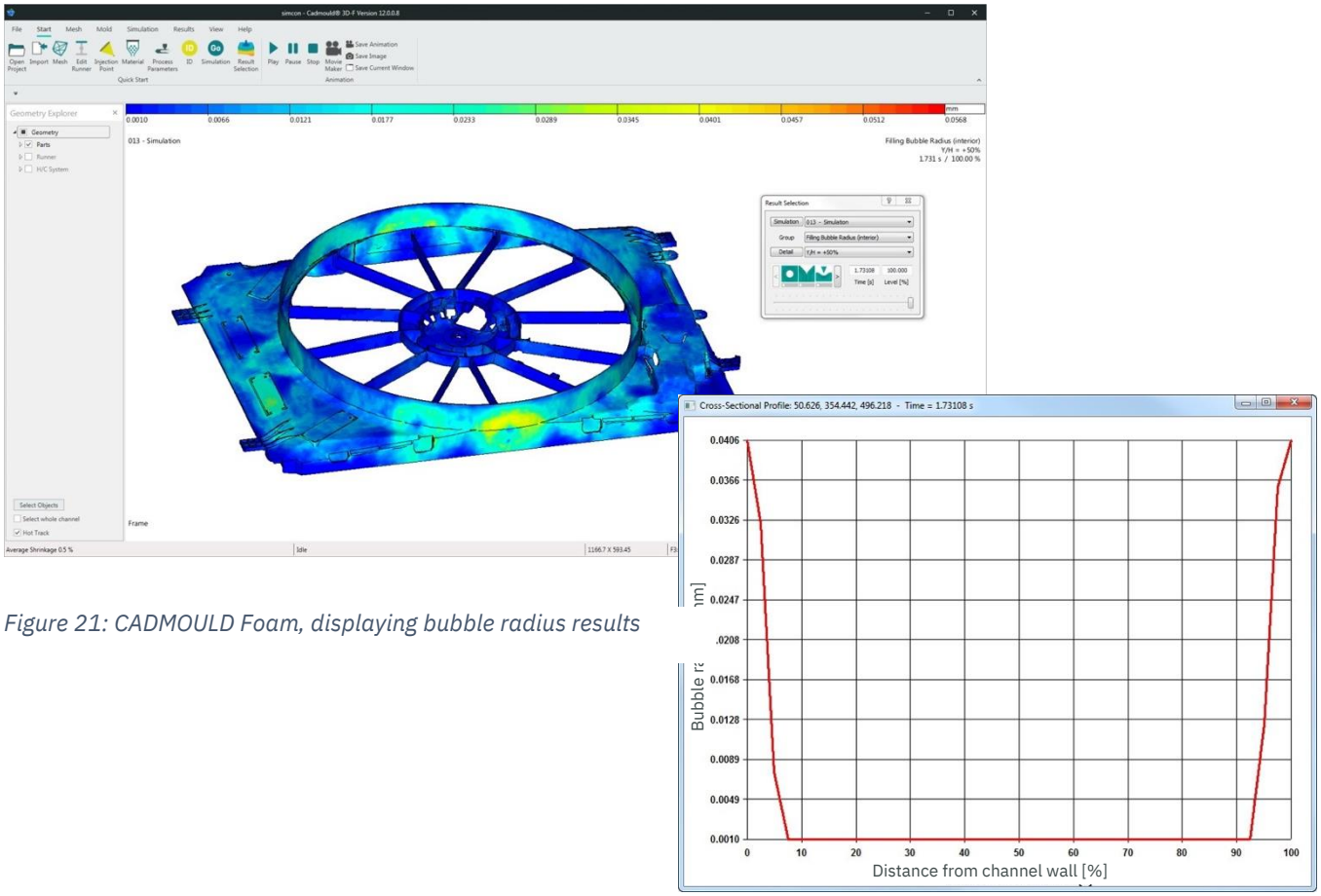


Figure 21: CADMOULD Foam, displaying bubble radius results

CADMOULD Foam enables the **simulation of foam injection molding**. You can simulate all common chemical and physical foam injection molding processes, such as MuCell®, Cellmould® and Optifoam®. CADMOULD Foam computes the following results, for foam materials:

- **Filling**
- **Density distribution** in the part
- **Bubble distribution** and size
- **Clamping** forces
- Component **weight**
- **Cooling** times
- **Weld lines** and **air inclusions**
- **Pressure** distribution
- **Temperatures**
- **Flow speeds**
- **Shrinkage and warpage**

Foam builds on the following functionality from other modules: filling (Fill module), holding pressure and cooling phase (Pack module), and shrinkage and warpage (Warp module).

Benefits

- **Detect filling problems** early on (air inclusions, weld lines, etc.), taking into account the influence of the foam on the viscosity
- Optimize **propellant and gas / mass** ratio
- Optimize **part weight and density** distribution
- Anticipate and fix **shrinkage and warpage** issues for foam projects
- Determine **cycle times** and **clamping forces** for foam projects

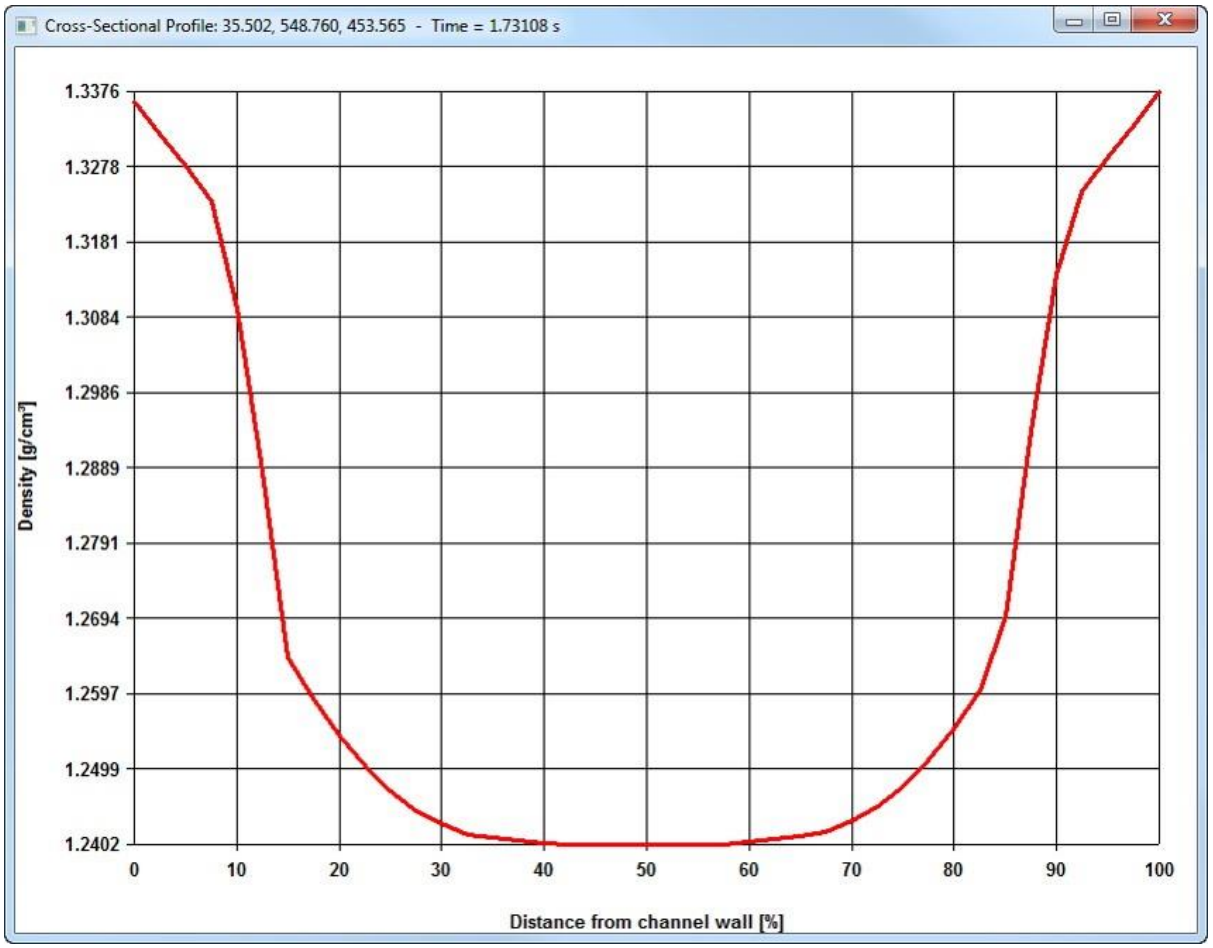
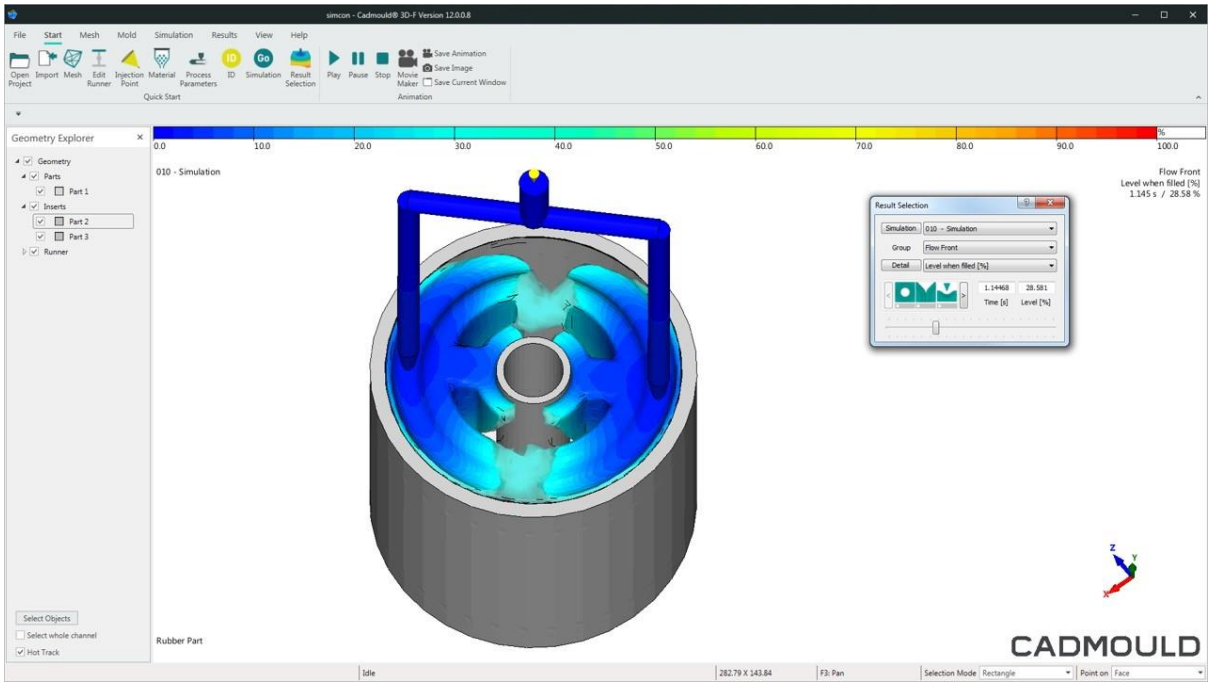


Figure 22: CADMOULD Foam, displaying foam density results along a cross-section of the part

CADMOULD RUBBER



CADMOULD Rubber enables you to simulate elastomer injection molding. It computes the following results:

- **Filling**
- **Weld lines**
- **Air inclusions** and venting
- **Pressure distribution**
- **Temperatures**
- **Shear rates**
- **Scorch**
- **Degree of cross-linking** (also after demoulding)
- **Heating time**
- **Shrinkage**
- **Warpage**

CADMOULD Rubber is available in two forms. You can either acquire it standalone, or as a module that builds on and works best with the following other modules: Fill, Pack (holding pressure and cooling phase), Warp (shrinkage and warpage), Cool and T-Box (thermal mold design).

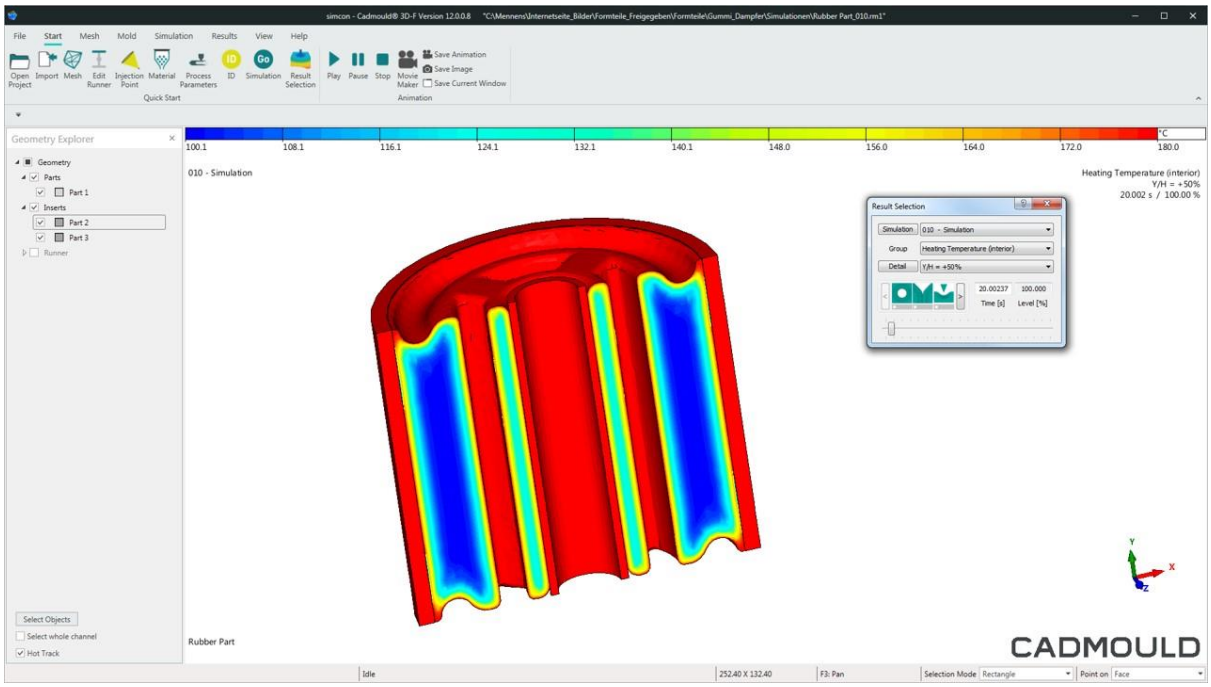


Figure 24: CADMOULD Rubber, displaying the interior heating temperature

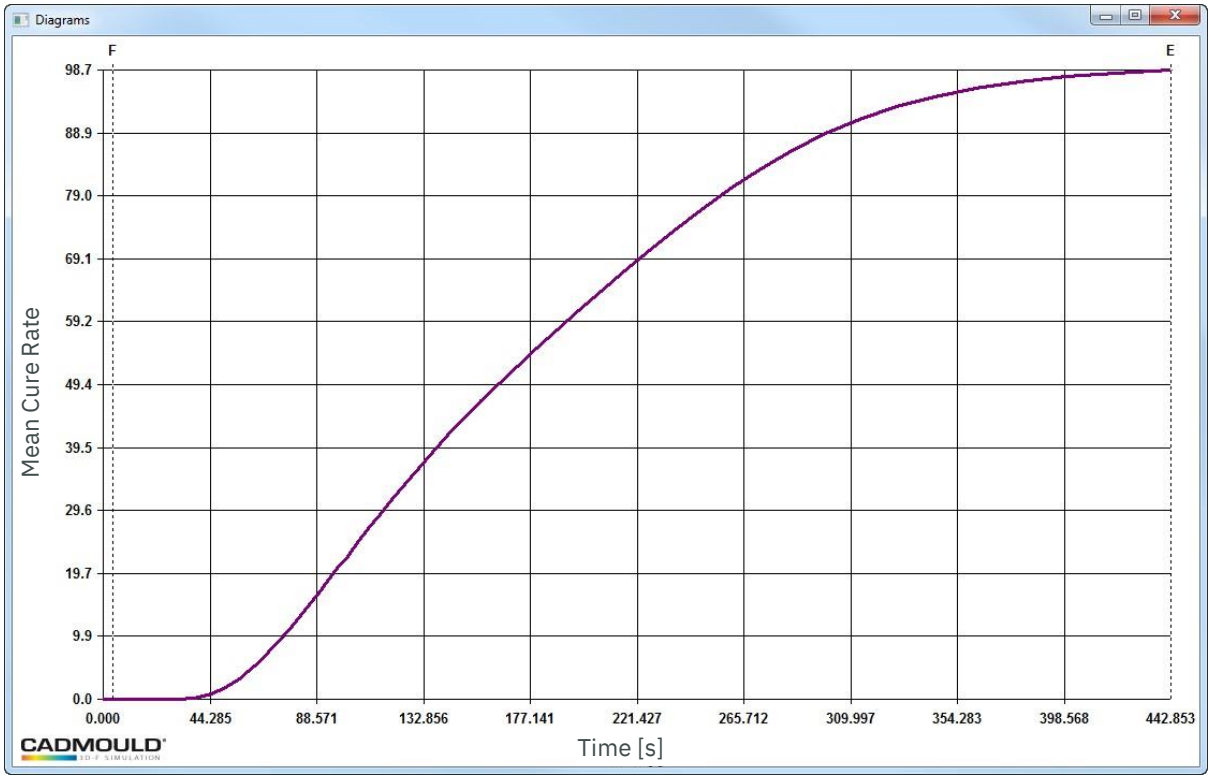


Figure 23: CADMOULD Rubber, displaying the evolution of the mean cure rate across time

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