

Application Note

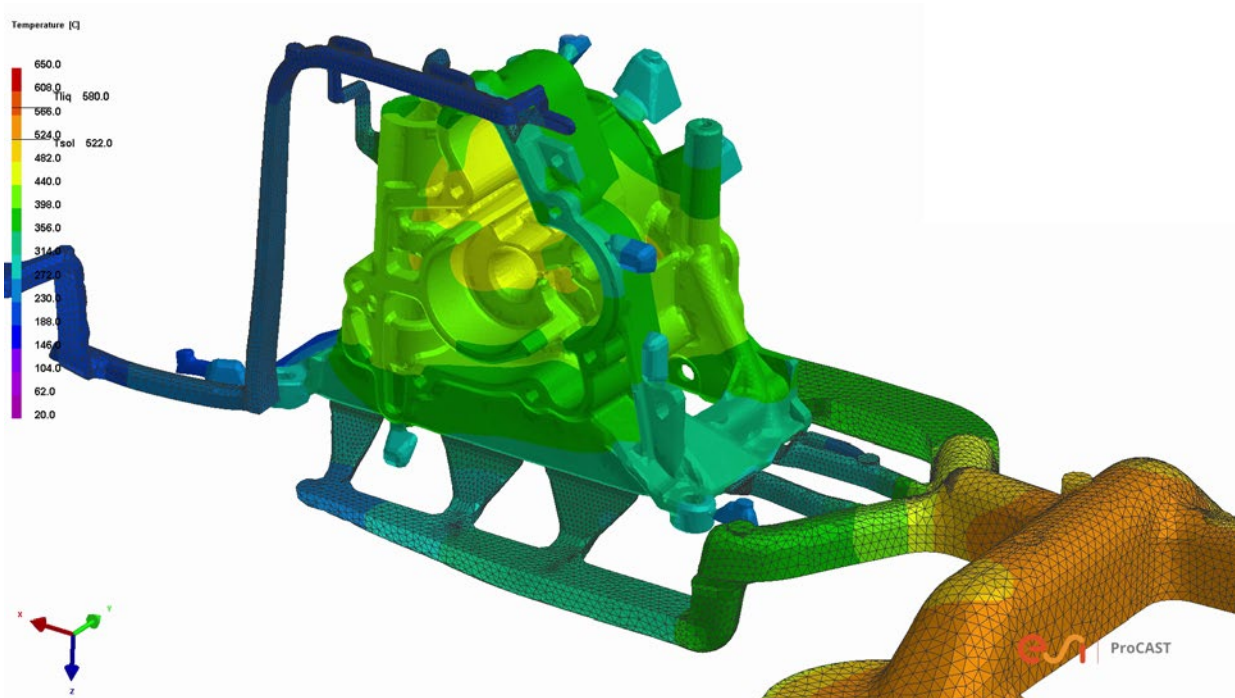
The Future of the Foundry: Dimensional Verification (using GOM Inspect Professional) of Virtual Simulations using ProCAST

City/Country: Brescia, Italy

GOM software: GOM Inspect Professional

Division: Design, foundry, simulation of casting processes

Simulation software programs for casting identify metallurgical defectiveness, mechanical properties and deformations of parts, and are fundamental for operating in a market that requires the rapid manufacture of difficult pieces, and which leaves no room for mistakes, testing or re-sampling. ECOTRE Valente, specialists in the simulation of metallurgical processes, use GOM Inspect Professional for the dimensional analysis of virtual pieces, in order to predict and rectify the onset of problems linked to shrinkage and warpage.



The ProCAST stress module calculates shrinkage and deformation over the entire mold and casting during filling, solidification and cooling.

Historically, Italy has always played a leading role in the field of metallurgy, and is one of the world's leaders in the production of ferrous and non-ferrous metals; the area around Brescia, in particular, has traditionally had a strong metallurgical bent – it is a land where metal technology has deep roots. Tiziano Valente, the founder of the corporation that bears his name (ECOTRE Valente), has metallurgy in his DNA and passed this on to his son Lorenzo, and shares his wealth of experience with the whole ECOTRE team. Since 1996, the corporation has been the exclusive distributor in Italy of software simulating foundry and steelwork processes, and in 2010 it branched out to include cold forging, hot forging, molding, lamination, extrusions and thermal treatments; ProCAST, QuikCAST and QuikCAST Lt are three of ESI's simulation software programs for casting. Thanks to their profound knowledge of metallurgical processes and of the associated problems, ECOTRE has become an industrial focal point of the ESI group – a global leader in the field of virtual-simulation services and software. In 2018, ECOTRE became the top European center for virtual foundries 4.0, thanks to its network formed by five offices in Germany: Munich, Stuttgart, Neu-Isenburg, Darmstadt, Dresden, Essen and Wolfsburg. "We can virtualize everything created that is metallic – be it liquid or solid," underlined Lorenzo Valente, ECOTRE's CEO.

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Lorenzo Valente, CEO of ECOTRE

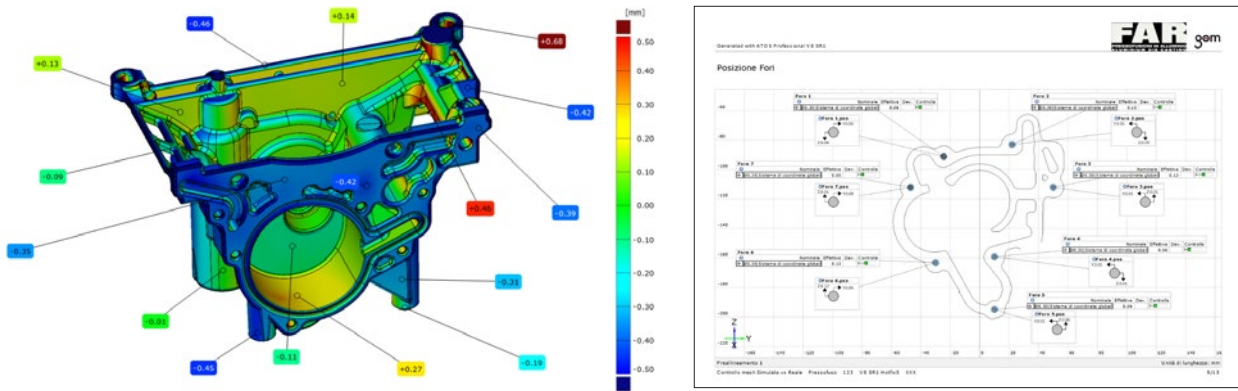
Predicting and preventing defective castings

For the last 20 years or so, the main problem for those working in steelworks and foundries was linked to the need to work out – with the highest possible accuracy – the typical defects within a given process, so as to be able to intervene and rectify defects before the production stage: shrinkage porosity, porosity from gas, the formation of cracks and all other defects typically seen in metallurgy. "The simulation software converts native data into mathematical equations and allows us to predict the occurrence and the formation of these phenomena in a scientific way," underlined Valente. The calculations at the basis of the simulation programs are not drawn from a large database in order to predict the result in a more or less empirical manner, but instead provide an objective forecast of what happens to the metal during the process. Depending on the models of calculation used by the various programs, and on the boundary conditions, it is possible to obtain very reliable simulations, thanks to which operators are able to choose the best solution for the lowest cost.

Given the positive outcomes, use of the three software programs ProCAST, QuikCAST and Quikcast Lt has spread rapidly in the sector (which has seen the benefits thereof), and has raised further questions: "Having resolved the defect issue, operators have shifted their focus to the dimensional aspect, which was initially of secondary importance." In other words: having noted that the numerical simulation provides a reliable result and allows you to rectify casting defects before starting the process, is it possible to evaluate – in an equally reliable manner – the behavior of the workpiece during solidification, so as to better understand shrinkage and contractions?

Assessing dimensions on the ProCAST virtual model

With the ProCAST software, this type of analysis can be performed using a very comprehensive process, simulating a machine that produces virtual pieces as if they were physical ones; the dimensional verification can be proven only in retrospect, by the physical measurement of the prototype.



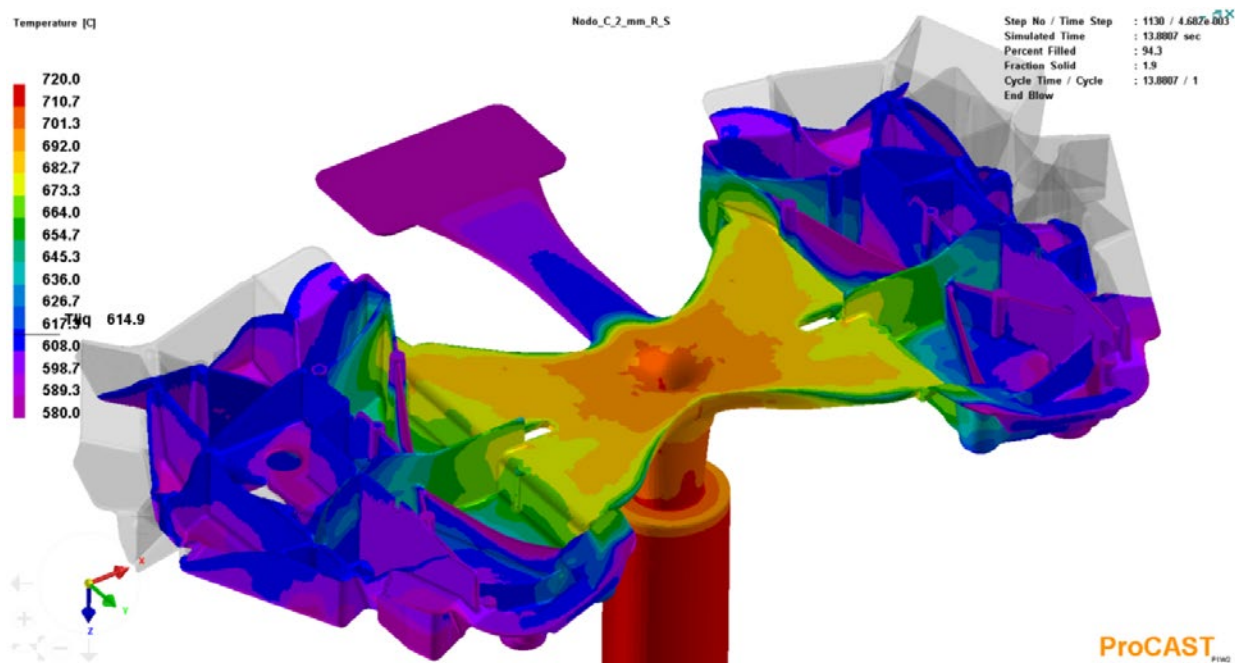
Predictive dimensional control. Comparison between nominal CAD model and current model produced by ProCAST. Verification of hole position.

For ECOTRE, there is a need to implement a dimensional check of the virtual model in the simulation, whereby this check must provide reliable results and be easy to perform. For this reason, the group invested a lot of time in this matter, until some GOM metrological solutions became evident. “We attended the training organized by GOM Italy, which enabled us to deepen the operation of technologies used in dimensional controls: we came across GOM Inspect Professional, and the world opened up to us,” explained Valente, the enthusiastic engineer. “We learned how the dimensional checks are performed when faced with the physical point cloud, scanned with the CAD 3D model, and in this way we realized how we should proceed”. By pooling a passion for challenges and sharing their technological approach, GOM Italy and ECOTRE Valente began to work together, and in 2016 presented their initial findings demonstrating the effective forecasting capacity of the ProCAST simulation tool, in terms of defectiveness and dimensions of the final product. A Copernican revolution, supported by data which is objective, real and easily assessable, is on our doorstep. It is quite different from the classical approach whereby the simulation is followed by a comparison of results with those of the physical prototype. “Corporations have understood that the integration of ProCAST simulation software and GOM Inspect Professional introduces dimensional verification into the cycle of planning and industrialization, thus providing the possibility of intercepting and resolving any problem before even reaching the production stage,” underlined Valente.

An unchanged verification methodology

One aspect of this interaction which is certainly revolutionary, aside from the reliability of the procedure, is the verification methodology, which is unchanged with regard to traditional processes. In practice, the user performs the casting simulation with ProCAST (filling, solidification, stress, heat treatment and microstructure) resulting in a point cloud in the form of a *.G3D file, representing the virtual piece once it has been withdrawn and deformed.

Professional, in order to identify and resolve any weaknesses in the same way as it would treat a cloud obtained from the optical scanning of a prototype. In fact, those working in dimensional verification treat the cloud as a sort of black box within the cycle, and continue to operate in exactly the same way as they did previously. The introduction of GOM Inspect Professional right after the numerical simulation is a huge benefit, because it does not disrupt the work plan and permits the maintenance of the same operating methods, optimizing the product development cycle, right down to the execution times for individual steps. Indeed, the integration of ProCAST and GOM Inspect Professional significantly shortens the overall process time because it reduces the prototyping and sampling steps to a minimum.



ECOTRE Valente: State-of-the-art technology ProCAST

As mentioned above, ProCAST outputs a file in its native *.G3D format, which is imported directly into GOM Inspect Professional. This is possible thanks to the mutual trust shown between ECOTRE and GOM Italy: “The level of collaboration has been so strong that GOM Germany shared its profound understanding of the problem with ECOTRE, as well as its capacity for innovation and the value of the work done together with GOM Italy, and authorized the use of its codes to generate a file in the native *.G3D format, thereby eliminating potential uncertainties due to the conversion process,” underlined Graziosi Gabriele, GOM Italy’s CEO.

Design loop and completely virtual verification

Although this may be presumptuous, it is certainly supported by the facts – the work done by ECOTRE and GOM Italy represents a real turning point because it has allowed us to break down the invisible barriers between the different divisions. There is much talk about Industry 4.0, but in reality the division of roles is still very marked: the design team struggles to have a direct dialog with Quality Control, and until a short time ago, not having the same working methods (3D design, insertion into a two-dimensional table, etc.) impeded

that dialog. Indeed, the technical and quality teams met only once the physical piece had been produced. The advent of solutions based on CAD systems and on ERP applications has facilitated communication between the CAD / technical department and other areas of the business, thereby improving competitiveness. By introducing GOM Inspect Professional to support the planning of the casting process, ECOTRE and GOM Italy have forged a virtual bridge between the work of the technical team, which processes the simulation, and Quality Control, which can now contribute without needing a physical piece with which to work. The two offices work together to fine-tune the process even before the product is made. So the integration of the ProCAST and GOM Inspect Professional software means that the design-verification loop becomes entirely virtual and can be done at zero cost, as it does not depend on prototyping. As well as the design phase, the plan for the verification is completed, i. e. the verification of physical pieces during the production process. In the meantime, the same plan serves to verify the simulation in GOM Inspect Professional. Moreover, this validation is carried out by staff trained in checking dimensions, and who are able to best interpret the result promptly.

ProCAST: proven reliability

“At the heart of all this reasoning, it is essential that there is an awareness on the part of users that ProCAST provides a very reliable simulation of the process as it happens in reality. This check was the first step in our collaboration: by applying GOM methodology and systems, we have proven that the simulations are reliable. As a result, if the simulation is correct, the dimensions will also be consistent in terms of the simulation. The prototype is not made until the validation of the solution – including dimensional validation,” highlighted Mr. Viscardi Cristian (engineer), ECOTRE’s Technical Director.



ProCAST’s reliability has its foundations in the calculation model, itself based on the finite elements method, which enables complex geometries to be managed with relative simplicity, and describes the behavior of the materials through elastoplastic models. This allows the simulations to mimic what happens in reality. Other software, like QuikCAST and QuikCAST Lt, ESI’s other two packages are based on different calculation engines, e.g. finite differences, and are not able to correctly predict the dimensions using stress-solver calculations. Added to this is the ECOTRE engineers’

deep knowledge of the processes and metallurgy which they use to define the models.

As a result of the great collaborative experience and the excellent results, ECOTRE and GOM Italy are replicating the project with the DEFORM software, produced by the American corporation SFTC, for the dimensional analysis of the simulation of molding, pressing and heat-treatment processes. The results are excellent also in this respect, but that’s another story.

ECOTRE Valente

ECOTRE Valente has been the exclusive distributor in Italy of FONDAREX vacuum-sealing equipment and of state-of-the-art simulation software for over 30 years. ProCAST, QuikCAST, QuikCAST Lt and DEFORM. ProCAST, QuikCAST and QuikCAST Lt are simulation software packages for casting, produced by the ESI Group – the only group in the world to have two calculation engines – finite-element and finite-difference – for foundries and steelworks. Thanks to their deep knowledge of metals, and of metallurgical process and techniques, the ECOTRE engineers are able to support customers in performing numerical simulations in order to optimize the product, the mold and the process as a whole.

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