



## INJECTION MOLDING

*A leading manufacturing process*

**AVENTICS Pneumatic Solutions, by Emerson, Optimizes Tool Correction Process with RX Solutions X-ray tomography solution.**



**As part of Emerson Automation Solutions, AVENTICS is one of the world's leading brands in pneumatic components and systems. The group provides products and services for industrial automation as well as other industrial fields.**

### **X-ray computed tomography at Aventics**

X-ray computed tomography has been used for many years by Aventics for the inspection of injected parts and complex assemblies. Aventics first discovered this innovative technology thanks to RX Solutions' services department, especially for checking assemblies and looking for defects in their parts (porosities, inclusions).

Thanks to x-ray computed tomography, complex assemblies can easily be checked without disassembling or destroying the part.

The company integrated a CT system from RX Solutions into their R&D department to reduce the required time for warpage and shrinkage compensation in injection molding.



**Installed in the measurement laboratory, the start-up of the RX Solutions tomograph is fast and intuitive.**

The RX Solutions tomography system is used on a daily basis for inspection and expertise: R&D, First article inspection, CAD comparisons, etc. The CT system is also used in production support, for the inspection of components after assembly to check the integrity and correct positioning of the different components.

### **Plastic components, for every industrial field**

The use of components made from plastic materials has increased in almost every type of product development – from consumer electronics and vehicles to aerospace interiors and medical devices. There are multiple reasons why this trend, which began decades ago, should continue. Plastic components are generally less expensive to produce and lighter in weight. In short, plastics are best suited to meet the needs of increasing numbers of today's manufacturers for product growth.

“At first we were looking for a solution to improve our expert analysis level and validate R&D calculation and simulations. The parts we manufacture are mainly complex assemblies hence tolerances stack-up is very important especially when several parts need to be taken into account. Thanks to x-ray computed tomography, it's easier to validate stack-up tolerance on real parts and visualize seals or spring in real conditions, without having to disassemble and take the risk to lose precious information. The other reason was to save time for new product development.

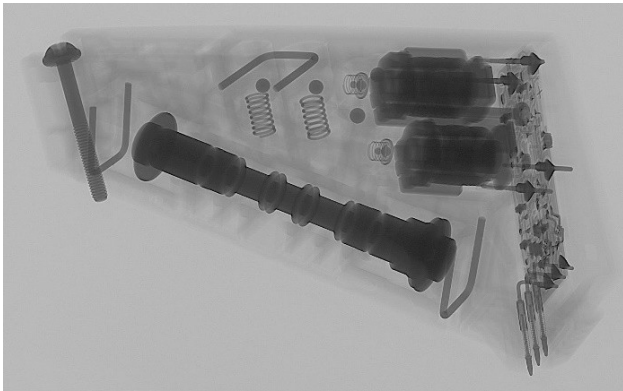
With x-ray computed tomography, we are able, in less than 2 hours, to validate a complete stack-up on a real part under pressure whereas without X-Ray it would take at least 1 day with dimensional measurement of each part in tolerance stack-up and calculation with the risk of error.”

**Nicolas VIDAL**

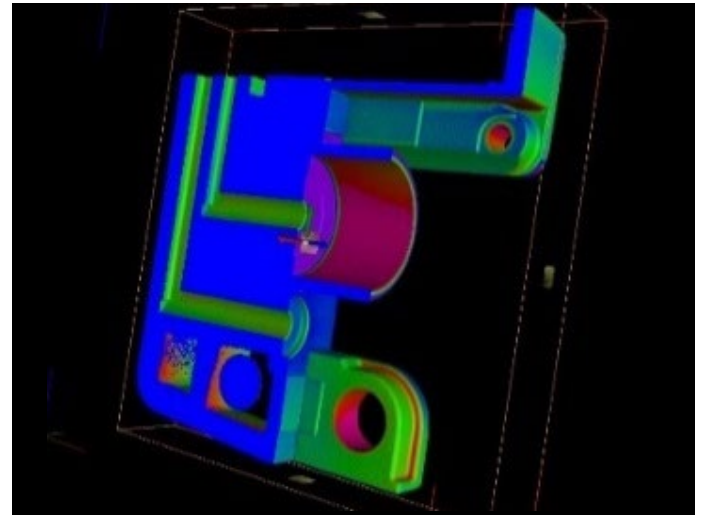
Head of Pneumatic Laboratory







3D rendering using X-ray computed tomography. The different parts can easily be distinguished in a non-destructive way.



CAD Comparison: a real part (First of tool injection) is compared to the CAD model

Plastic injection molding manufacturing process is used to design and produce high volumes of the same part. Obtaining the perfect geometry of a plastic part is a complex process. Thus, there are several optimization steps for the material such as the mold itself and the injection settings.

As stated above, injection molding can be a complex process whereas shrinkage compensation and warpage remain an omnipresent topic. Even if the molds are strictly made according to the drawings, the parts produced are usually not true to size. The main defects (shrinkage, warpage and porosities) mainly come from inhomogeneous cooling due to the volume distribution and the filling process. Traditional measurements methods to compensate for these defects are often time and cost consuming.

This is where computed tomography comes into its own, allowing the first molded parts to be checked out non-destructively. X-ray computed tomography is the perfect technology to assess in a few minutes a plastic part, on structural and dimensional aspects. CT scanning quickly provides the ability to overlap actual scan data with that of the original CAD model, or the golden sample showing user-defined criteria, comparing actual values to nominal values and displaying out of tolerances values in easy-to-see colors.

## Computed Tomography, take all the benefits of X-ray vision

Compared to other technologies, X-Ray CT does not need any particular preparation on the sample to be done. No spray, no stickers, no probing program, the only thing that needs to be carried out before launching a scan is to choose a good orientation and an adapted sample holder to accommodate the part inside the system. Then everything can be automated and well-integrated in a fully robotized production line.

Furthermore, Industrial computed tomography is making its way into molding industry for fast adjustments and corrections on injection molds. In plastics engineering, X-ray computed tomography supports and speeds up all phases in injection molding, from prototypes to first of tools (FOT).

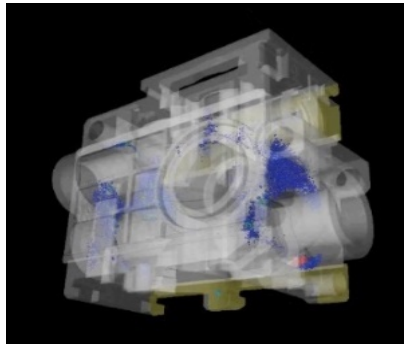
*“In addition to Engineering savings, X-ray is a crucial device for injection molding process. It allows to see quickly the deviations between a CAD model and the injected part and reduce correction loops of the mold. It also helps us to improve our molding process by visualizing areas where venting is needed based on porosity analysis. Finally, it's very easy to see burrs and spindle deviations. Saved time is counted in weeks”*

**Nicolas VIDAL**

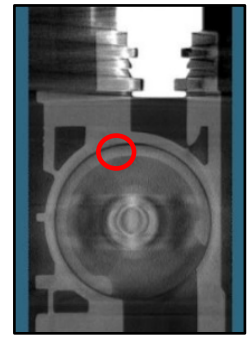
Head of Pneumatic Laboratory



Real part



3D CT rendering with a porosity analysis



Under pressure, leaks appear on the metal parts. Leakage area can easily be seen on the 3D slice in RX Solutions X-Act software.

## X-Ray CT, an imaging technology that saves a lot of time in the Injection Molding process

Qualifying a mold is a long process, and always start by the injection of a so-called first of tool (FOT). Then comes the First Article Inspection (FAI) step, where the first of tool is carefully measured to accurately compare its design to the original drawing model.

The entire development of a new mold is a long process which can take months. CT scanning is a fast and accurate technology that gives in a few minutes a complete scan of the part, without worrying about the part's complexity. In addition, x-ray computed tomography gives a way on a single scan to measure multiple parameters, external as well as internal features. X-ray tomography doesn't care about the complexity of the part. Whatever the type of part, tomography brings an answer and allows to get a result directly in a few minutes.

## Product development: Test and qualification

### Case #1: Tomography of a new valve serie production

Aventics developed a new valve with a robust polymer housing that can be mounted individually or as a block. This valve features fast connections for pneumatic tubing.

Initial pressure tests of the part showed leaks on the assembly, rendering the part not in accordance with quality standard. In order to identify the probable causes of this leakage, an X-ray tomography check allowed the leakage areas to be located.

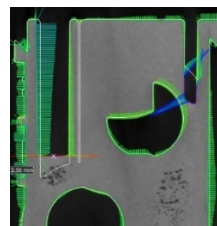
CT scanning allows the identification of problems without having to disassemble the part. It's useful to identify a problem that could not be identified by examining disassembled components.

*"In this case, a complete analysis has been made within 2 hours. X-ray computed tomography gives a way to quickly locate the leak origin, without having to cut and destroy the part. X-ray CT avoids the risk of cutting the defective area. CT scanning pictures are clear and easy-to-understand, thus helps the communication between departments (R&D, Production, Quality ...) to quickly solve the issue avoiding redundant e-mails and oral descriptions."*

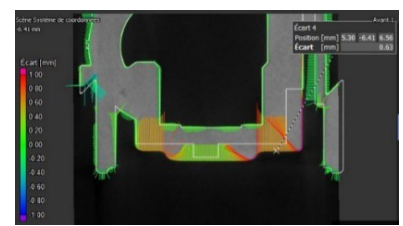
**Nicolas VIDAL**

Head of Pneumatic Laboratory

X-ray computed tomography allows several analyses to be performed on the same dataset: visually locate a defect, make a CAD comparison or perform a porosity analysis. This is what has been done on the valve, to understand the leak origin. Deviations between the theoretical and the real part may be the cause of this defect:



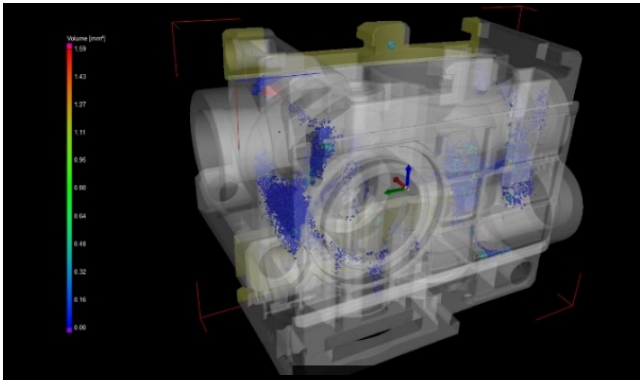
Theoretical contour vs real contour CAD



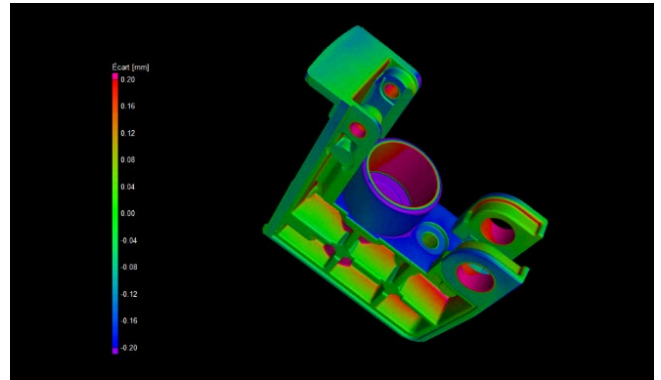
Theoretical contour

The picture above shows a real gap between the real contour of the part and the original CAD file. These gaps are probably at the origin of the leakage.

On the same dataset, another interesting analysis that can be made: porosity analysis



Porosity analysis on the valve assembly. A color code displays the size difference between the different porosities.



CAD comparison on a plastic cover.

## X-ray CT scanning as a Measurement technology for mold qualification

CT scanning is an essential technology for non-destructive 3D characterization of all types of industrial components or assemblies. CT is the best technology to get a fast, non-destructive and detailed examination of the internal and external structures or of an industrial component or assembly. With just a quick CT scan, every structural and dimensional aspects of a workpiece can be assessed through a simple CT dataset.

One of the main applications of X-Ray CT when talking about plastic injection molding industry is the mold design qualification and optimization. It is indeed one of the longest tasks to achieve when launching a new plastic part production. Warpage and shrinkage have to be measured and taken into account in order to modify the mold geometry. One of the best ways to obtain the inner and outer shapes of an injected prototype is then to use X-Ray CT. It is effortless to generate a three-dimensional mesh of the whole part, compare it to the Computer-Aided Design (CAD) model and modify, according to the differences, the related mold. The comparison of the geometry of the molded part can occur with a CAD file or a master samples, or between single features, among different molders, materials or after heat treatment or wear.

With CT scanning, the total time required to assess the shape and size of test parts can be highly reduced. The number of iterations is reduced while the loss of resources and the cost of final mold production are reduced.

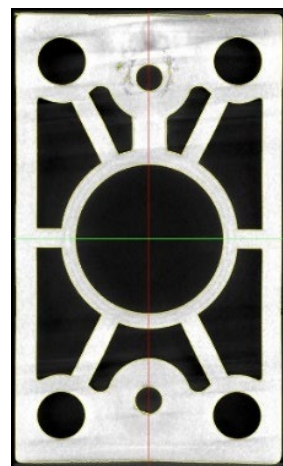
When manufacturing plastic components using injection molding technology, if a change of supplier occur, it's important to be able to check whereas the part meets the quality requirements or not. In a few minutes, X-ray CT gives a way to scan the part and check for the part quality.

By performing a scan on the prototype, the conformity of the part to a CAD file or a reference sample can be evaluated in less than an hour. These evaluations are carried out using VG Studio Max software, which coupled with a CT equipment allows multiple analyses to be carried out.

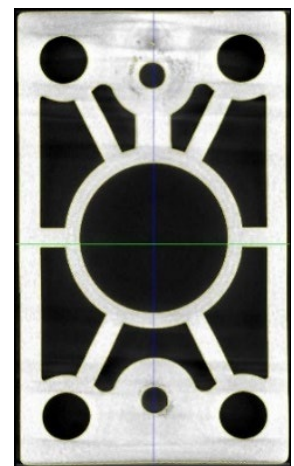
### Case #2: X-ray CT comparison on a plastic cover

Looking for new injection suppliers always goes through a qualification stage. CT scanning allows the part that comes out of the mold to be compared easily and quickly with the original CAD or with a golden sample.

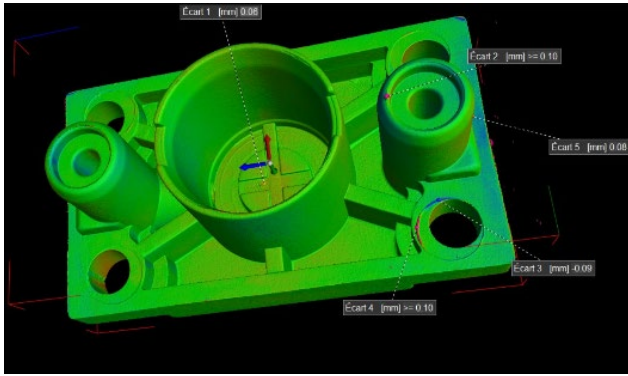
It is exactly the same when a mold is moved to another production site, the mold qualification must be able to be carried out as quickly as possible. Below an example on a plastic cover where the two injected parts can easily be compared on their two main characteristics: geometry and quality.



Supplier A



Supplier B



CAD comparison between the golden sample and the first of tool.

## CT Scanning to look for defects

X-ray CT scanning is ideal to look for defects. It can actually be used to see how assembly fit together. Aventics use this technology to inspect and control in a fast way plastic welding.

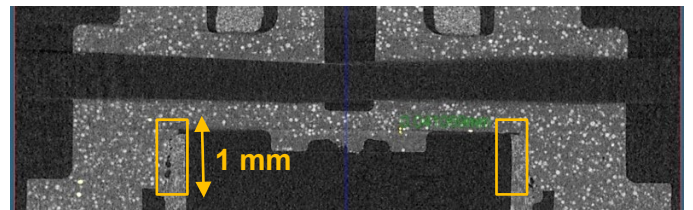
A large variety of welding defects can be found thank to CT scanning: lack of penetration, lack of fusion, undercut, slag inclusion, cracks, porosity, overlap, warpage...

All these defects can considerably affect the parts' behavior and properties. In a few minutes, CT scanning gives a way to assess the complete part, in a non-destructive way.

### Case #3: Welding analysis

Friction welding processes are widely used techniques for the assembly of plastic components. Correct selection of welding parameters and component design are essential to successful welding using these processes.

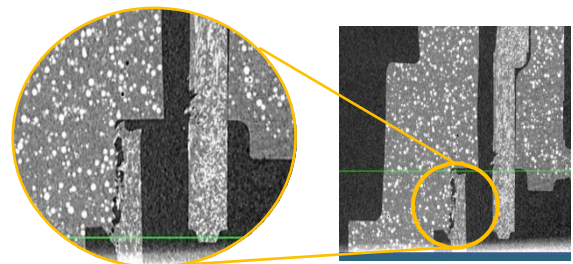
Plastic welding analyzed using x-ray CT:



Coil area welding analyzed by X-ray CT-1mm length

On the slice above, imperfections are observed all along the weld, which is not edge-to-edge. These imperfections can lead to a component defect, where the two parts can come apart or cause leaks to appear once the element is under pressure.

Coil area welding result:



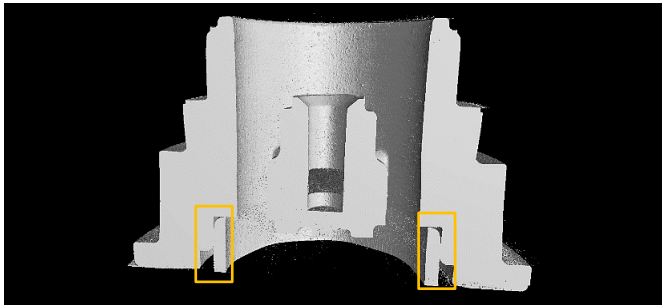
The welding is full of porosity imperfections. There are a lot of cavities in the welding, which can lead to part's misbehavior and leakage in real conditions.

"In the event that a mold is moved to another production site, X-ray computed tomography is the perfect technology to quickly qualify the mold and guaranty the quality of parts. CT scanning saves days in injection molding process and comes as an additional mean to assess a mold. In parallel to the standard lifetime validation test for dynamic part, x-ray computed tomography comparative scans are truly helpful. With dimensional analysis and porosity visualization, we can check if a process deviation occurs. In that case, based on risk analysis, we can validate before end-of-life time test which usually takes 3 to 6 months"

### Nicolas VIDAL

Head of pneumatic laboratory





*An empty area all along the welding can clearly be underlined*

X-ray CT scanning aims to the possibilities of observing discontinuities without compromising the welded part.

- STL generation via X-Act or Volume Graphics
- Possibility to import the STL file in any software to make CAD comparison (Best-fit)

**Computed Tomography scanning is a powerful technology that can be used for a variety of applications, ranging from material analysis to assembly inspection passing through CAD comparison & dimensional measurements.**

**X-ray CT technology gives a quick and complete inspection of your injected parts in a non-destructive way. CT scanning opens up opportunities to understand the complete process, from design to end-user part.**

## **INDUSTRIAL COMPUTED TOMOGRAPHY HIGH PERFORMANCE X-RAY SYSTEMS**

RX Solutions designs and manufactures innovative non-destructive X-ray imaging systems. We also have a service department specialized in X-ray inspection.

RX Solutions' range of equipment covers all industrial and research applications in micro and nanotomography.

Discover more on RX Solutions at the following address:  
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