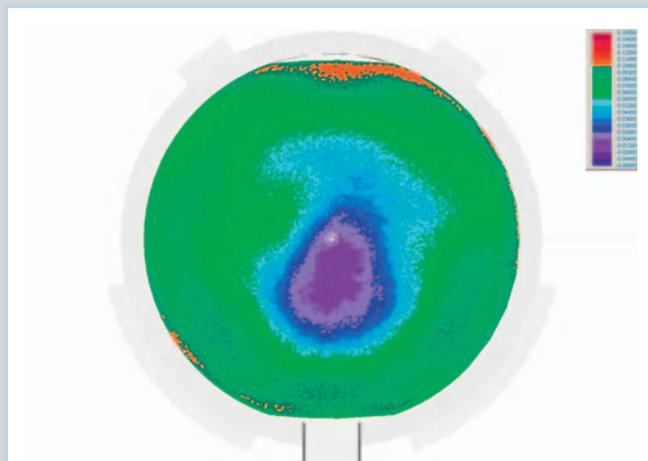
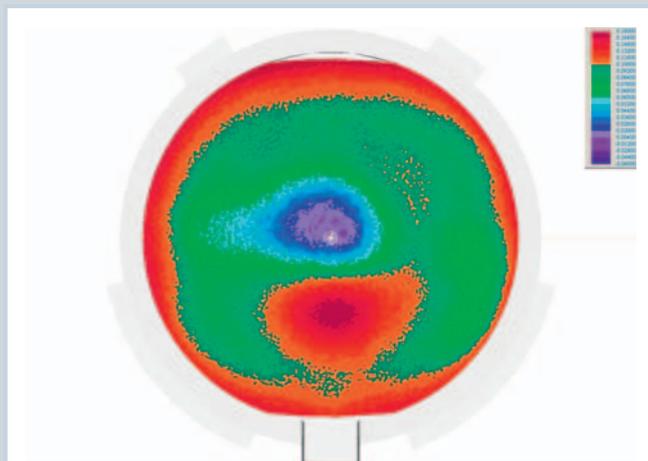


Application report  
Vema Werkzeug- und Formenbau GmbH  
Vema Technische Kunststoffteile GmbH

## Only one correction loop required

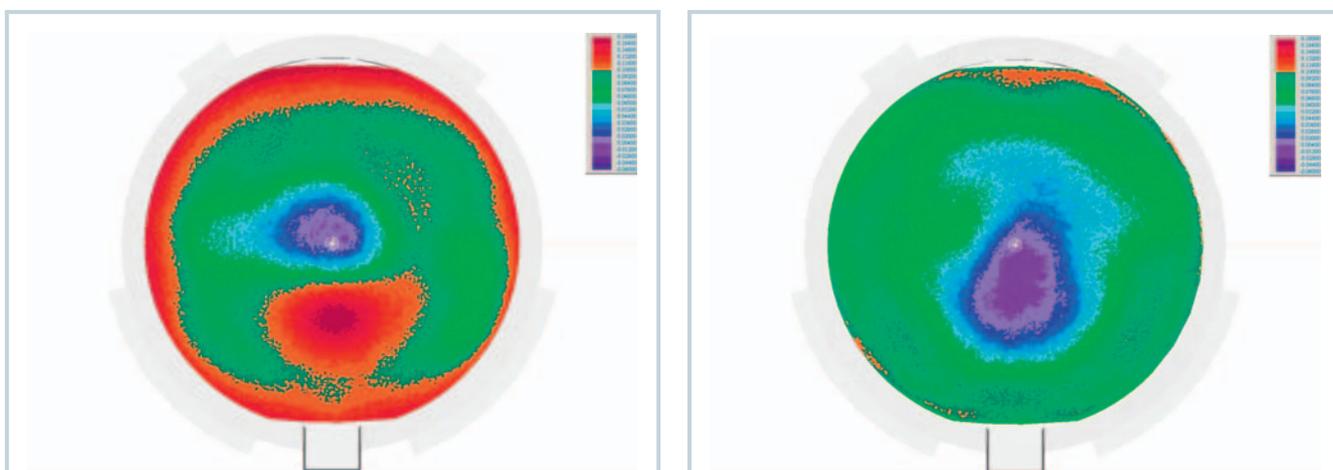


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## USING COMPUTER TOMOGRAPHY FOR OPTIMAL INJECTION MOLDS

# Only one correction loop required

Using computer tomography, it is now possible to measure first article parts precisely and meaningfully. The necessary corrections can then be transferred to the injection mold machine in just one step.



**Before – After:** An LED lens before (left) and after the tool correction. The components were measured using computer tomography. Dimensional deviations from the target data can be seen at a glance using color coding. After one correction loop, the result is in the green zone.

**IN THEIR INJECTION MOLD SHOP,** Vema GmbH produces very exact technical plastic components. Werner Vesper is the managing director of the company. In order to produce these injection molded parts, such as LED headlight lenses, Vema previously had to rework the molds in several correction loops before they could be released.

## Measurement service with roots in toolmaking

When looking for alternatives to conventional measurement methods, Vesper received the suggestion to try computer tomography (CT). This method, which is widespread in the medical field, is still relatively new in the industrial world, despite the excellent results that have been obtained.

A lucky coincidence was that the recommended service provider, HeMa-CT, is located in Schönaich Germany,

about 100 km from Vema. “This made the initial contact and coordination easier. Even the first results were absolutely promising,” reports Vesper. “After we communicated and adapted our requirements, we had measurement and correction results that I had never dreamed of.”

Two innovative thinkers, Mark Waschitschek and Herbert Layher, are behind HeMa-CT – and a TomoScape from Werth Messtechnik. The two managers, who have roots in moldmaking for plastic injection molding, were employed at various supplier companies, and finally met each other at their last company. One was the technical director, the other the quality manager, when they started their search five years ago for improved

measurement methods for complex technical parts. At a trade show they discovered computer tomography, and quickly realized the potential for this technology.

## One machine for several users

One such CT measuring machine, however, would not be fully utilized by some smaller tool and die shops or injection molders alone. HeMa-CT thus became a service provider, using a TomoScape 200 from Werth Messtechnik, the first CT machine specifically developed for coordinate measuring technology.

One specialty of Vema’s is LED applications for the automotive industry. Werner Vesper explains: “We have developed a very specialized expertise,

so that many light designers come to us to have their ideas implemented in practice. Because we can provide moldmaking and injection molding from a single source, and our experience in both areas complements each other nicely, we are the ideal partner for mold development and initial series production.”

The production of lenses and reflectors, however, is no easy task. The products not only have to be as clear as glass, the surfaces are also critical. They must be absolutely flat and at a defined angle to each other. Deviations of just over two hundredths of a millimeter mean a loss in transmitted light of about 30 percent. Thus, very high precision is required for the optical functional surfaces in the final product. This is a challenge that must be met mostly by the molding tool, which must be designed for process reliability. The subsequent injection molding process is easier to master, compared to the mold making.

### Precise plastic components, using mold correction

In order to achieve the required level of precision, Vesper typically takes the following approach: He loads the customer's component-specific CAD data into his system, where the expected shrinkage for the specific type of plastic is first calculated in CAD. Vesper then generates the negative shape from the positive part, and designs the required mold. Using this CAD file, the NC program is generated in CAM-Part of the software. The tool shop can then mill out the mold and add the ejector pins, sliders, etc.

Using simulations and sample runs on

## i COMPANY

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**Lenses and reflectors:** These must not only be as clear as glass, the surfaces are also critical. They must be absolutely flat and at a defined angle to each other. This is a challenging task for the mold maker.

the injection molding machine, the mold is optimized until a reliable production process can be guaranteed. This means that critical dimensions stay within a tolerance of 0.1 mm. Now fine-tuning can begin, which requires that the injection molded products are measured with high precision. If deviations from the target data are found, then the mold needs to be

corrected accordingly. Thick-walled parts, in particular, which include the LED lenses, are subject to significant shrinkage. They require several correction loops with typical tactile measurements, due to the relatively low resolution of the measurement data.

Besides the limited number of measurement points, measuring with probes or other methods has another weakness in the lack of access to side surfaces and undercuts. The typical methods also do not have any way to measure the assemblies as a whole. This is important because the angles of the surfaces to each other and the relative

location of the light source are very significant. This means that the only option is to integrate dimensions obtained from several measurement runs, which means additional work and an additional source of inaccuracy.

### Initial sampling and mold correction using tomography

In computer tomography, an X-ray process, the workpiece is placed on a rotary axis between the X-ray source and the detector, which operates similarly to a CCD camera. It converts the X-ray image to a digital 2D image for further processing.

The unique feature of the Werth TomoScope is the combination of proven coordinate measuring technology and computer tomography. The benefit is measurement data with precision in the  $\mu\text{m}$  range that shows every detail of the workpiece and can be analyzed in various ways. As a rule, the point clouds are provided as an STL mesh ▶

## i MOLDMAKING AND INJECTION MOLDING FROM A SINGLE SOURCE

In 1982, Werner Vesper founded the Vema company with his partner, Josef Macho (who has since retired). It consists of two companies, Vema Werkzeug- und Formenbau GmbH (tool and mold making) and Vema Technische Kunststoffteile GmbH (technical plastic parts.) Both companies do about 60 percent of their work for the automotive industry. 30 percent is in sanitary engineering, and 10 percent is for medical technology. The injection

molding shop employs 40 people, and mold making employs 20. From the beginning, the company dedicated itself exclusively to developing and producing technically challenging plastic components. Today, Vema GmbH is a certified company under ISO TS 16949, and offers its customers complete service, from co-development of injection molds and plastic components, to the finished part, and rounded out by an in-house assembly department.

that can be edited and easily optimized. For Herbert Layher and Mark Waschitschek, it soon became clear that this method was ideal for article inspection of plastic components, but also, as Werth proposed, for mold correction. “We are both practitioners and wanted to apply our knowledge from mold making and injection molding. So it was never our goal to be purely a measurement service provider. At Vema, we have been able to demonstrate that CT is ideal for mold correction.”

In practice, it works like this: instead of performing a tactile measurement, Werner Vesper brings the injection molded component to HeMa-CT. There the part is “X-rayed” in the TomoScope. An STL file is generated from the 3D point cloud, which can be compared to the original CAD data. Deviations can be seen at a glance using a color coded plot.

“If the part is within the required tolerance, then the data is entered in the first article inspection report, and we’re done,” explains Mark Waschitschek. “If there are defects, we can clearly see the areas that need changes in the mold. In this case, we get our partner involved, the CAD and measurement specialist Carlos Machado.” Working with Werner Vesper, Carlos Machado processes the STL data obtained from the Werth TomoScope. He reverse engineers the areas to be corrected, using his CAD/CAM system, reconstructs the deviations to be corrected, and inserts the areas to be optimized into the original mold CAD file. He uses an example to clarify the underlying principle: “If a cup is supposed to be round, but comes out of the injection molding machine as an oval, then I transfer the spatial deviations to the mold on the other side.



**Correction.** Herbert Layher (left, HeMa CT) and Werner Vesper (Vema) inspect the molds, which are the foundation of high-precision plastic components. After measuring the first injection molded parts, one or more corrections must be made to the mold to optimize the precision of the parts..

This compensates the defect and the next cup comes out of the mold round.” Vema already used this principle, but not with this level of accuracy. This is because, for an optimal application, a measurement probe can only take a hundredth of the measurement points that CT can manage within a reasonable period of time. Werner Vesper is very pleased with the work of HeMa-CT and Machado.

### Increased quality and time savings

He especially appreciates how simple the process is for him. “If a mold correction is needed, then I get a new CAD file, which I read and transfer into my CAM system, then generate the cutting paths for reworking my mold. Up to now, all the molds have been optimally adjusted without any further correction loops. We have increased quality and saved time.” For about one and a

half years, Vema has depended on the support of HeMa-CT and Werth computer tomography. Vesper also uses this innovative method to analyze plastic pump covers. He explains: “The entire volume is captured by the X-ray. This means that, with the right software, we can also determine porosity and shrinkage cavities. This provides us with important information about the injection process, and allows us to demonstrate the quality of our parts to our customers in the case of returns.” For companies who cannot afford their own TomoScope, but want to do the measurements and analysis themselves, Herbert Layher has this advice: “Get a PC with the Off-line WinWerth measurement software. This costs a fraction of the price of the whole system. We will then provide the STL files that you can analyze yourself.” ■

Translated by Werth Messtechnik GmbH