First Article Inspection of Aluminium Castings by Computed Tomography

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Abstract
Conventional analyses of aluminum die-cast parts require a multitude of different measurement and testing procedures. Industrial Computer Tomography reduces the effort involved in testing and increases the quality of measurement results. The foundry Pressofusione Saccense S.r.l. successfully integrated the exaCT® Volume scanning technology for first article inspection into their production chain, thus saving time and costs. At the same time the product quality was improved.

Keywords: Industrial computed tomography, CT based dimensional measurement, metrology, first article inspection

1 Introduction
In the process of approving the accuracy of die castings, the first article inspection needs to determine if the product meets the quality requirements. Traditionally, the first article inspection is performed using 3D coordinate measuring machines (CMM). However, performing the whole process of first article inspection by CMMs is rather time consuming. First of all, the part needs to be fixed and aligned in various orientations to access all measuring features. Secondly, to be able to measure internal features, the part needs to be cut in various sections. Apart from destroying the part, the process of cutting or milling may change the geometry, thus increasing significantly the measurement uncertainty. A complete first article inspection of complex die castings means piecewise cutting and measuring in several steps. This process often lasts for several weeks. Nowadays the time from order to production needs to be minimised in order to be competitive. Therefore, an alternative to the traditional measuring machines was needed. Computed tomography is able to perform such a task, provided that the CT machine is designed for metrology applications. Since January 2011 a CT workstation exaCT M has been used extensively for measuring aluminium die castings. After an internal acceptance testing, checking the accuracy and repeatability of the CT scanner, the CT has been used in combination with the metrology software Metrosoft Quartis as a routine measuring device.

2 Scanning technology and inspection process
To check aluminum die-cast parts faster, more completely and more cost efficiently, Pressofusione Saccense put into operation an industrial computed tomography system made by WENZEL Volumetrik. With the CT-Workstation exaCT® M200 HE (Figure 1) parts with a size up to 200 mm (diameter) x 300 mm (height) are checked.
In this article we describe the inspection of an aluminium die-cast part with a length of 110mm (figure 2). These parts undergo a material analysis, a dimensional check and a complete nominal-to-actual comparison based on computed tomography.

The scanning procedure is set up and carried out with the software exaCT® Control. This software allows the easy definition of scanning parameters. While the part is scanned, the captured data is reconstructed. This parallel mode of operation minimizes the needed time for data processing. At the end of the scanning procedure the reconstructed data is available as voxel (three-dimensional pixel) data as well as surface data (figure 3). This data is the basis for all following analyses.
A comparison of the scanned data and the CAD model is carried out to completely analyze form deviation and deformation of the part. The deviation of the real part to the CAD data is visualized with a color plot. Detailed information about the size of deviation can be displayed with labels. Figure 4 shows the deviations of the die-cast aluminum part with colors.

The dimensional evaluation of the part is carried out with the measuring software Metrosoft QUARTIS®. Element capturing, geometrical evaluation and reporting are done within the measuring software (figure 5 and 6). The surface data, captured with the industrial CT, is used for the probing of the measurement points. A once prior written measuring program can be selected and fully executed.
automatically. With this method even internal and the smallest structures, which cannot be measured by tactile or optical methods, can be dimensionally measured and evaluated.

Figure 5: Dimensional analysis with Metrosoft QUARTIS: Features to be measured by CT (subset)
3 Conclusions

The advantages of the metrology grade CT scanning technology are numerous: The CT measuring process allows for internal and external measurements. The part does not have to be cut and does not have to be fixed in different orientations.

The complete digitisation preserves a digital copy of the parts which allows performing any kind of measurement at any time. The CT based first article inspection significantly reduced the measurement time and helped to reduce the time-to-market.