Preliminary results of a proficiency testing of industrial CT scanners using small polymer items

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Abstract

This work presents preliminary results concerning a proficiency testing for intercomparison of industrial CT scanners. Two audit items, similar to common industrial parts, were selected for circulation. The two items were a single polymer complex geometry part and a simple geometry item made of two polymers. The items circulated among six participants in Denmark and Germany. The circulation took place between March 2011 and June 2011. This paper presents stability investigation of reference measurements carried out using tactile CMM and preliminary results from the intercomparison.

1   Introduction

Two audit items, more similar to parts commonly used in industry than commonly used reference objects in coordinate metrology, were selected for this industrial CT intercomparison [1, 2]. The two audit items, a single polymer complex geometry part (item 1) and a simple geometry item made of two polymers (item 2) are shown in Figure 1.
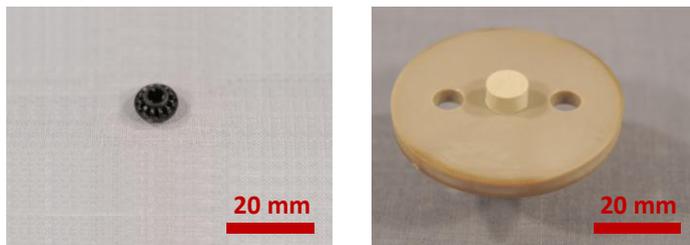

Figure 1: The two audit items, item 1 (left) and item 2 (right).

The selected geometrical features were height (M_1), diameter (M_2) and roundness (M_3), as shown in Figure 2. The polymer material of item 1 is not described due to confidentiality reasons. Item 2 is produced through a two component injection moulding process and consists of two polymers (polyetheretherketone for the disc and polyphenylenether for the top).
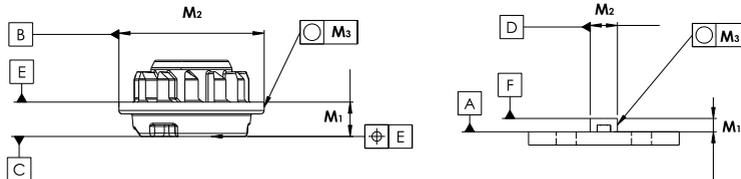

Figure 2: Item 1 (left) and item 2 (right) with relevant datums and measurands.

2   Calibration of audit items

An investigation on the stability of the items was performed through measurements using a tactile CMM carried out in March 2011, May 2011 and January 2012. ISO 15530-3 [3] was used for estimation of the uncertainty. The reference values and uncertainties are shown in Table 1.

Table 1: Reference values and uncertainties for the selected geometrical features on item 1 and 2. All values are in mm.

Item no.	Geometrical feature	March 2011	May 2011	January 2012
1	Height, M_1	2.026 ± 0.008	2.032 ± 0.008	2.037 ± 0.008
	Diameter, M_2	8.597 ± 0.022	8.580 ± 0.022	8.611 ± 0.022
	Roundness, M_3	0.021 ± 0.007	0.011 ± 0.007	0.020 ± 0.007
2	Height, M_1	3.906 ± 0.007	3.908 ± 0.007	3.915 ± 0.007
	Diameter, M_2	8.038 ± 0.023	8.008 ± 0.023	8.041 ± 0.023
	Roundness, M_3	0.028 ± 0.001	0.028 ± 0.001	0.029 ± 0.001

The observed behaviour over a period of time and the maximum deviation for the selected geometrical features for the items is outlined in Table 2 based on the results in Table 1. It was detected that the items changed over a period of time. The changes could be due to their polymer characteristics, which are affected by parameters as temperature, humidity and air pressure.

Table 2: Observed behaviour over a period of time and maximum deviation for the selected geometrical features for item 1 and 2. All values are in μm.

Item no.	Geometrical features	Maximum deviation	Observed behaviour over a period of time
1	Height, M_1	11	Increasing height
	Diameter, M_2	31	Decreasing diameter followed by an increasing diameter
	Roundness, M_3	10	Decreasing roundness followed by an increasing roundness
2	Height, M_1	9	Increasing height
	Diameter, M_2	33	Decreasing diameter followed by an increasing diameter
	Roundness, M_3	1	Approximately stable

3   Preliminary results from comparisons

In order to judge the agreement between measurements performed by each partner, a parameter E_n was computed according to ISO 17043 guidelines [4]. A value of $E_n < 1$ assures agreement with reference measurement results. The reference values from March 2011 were used as reference measurement results. Results are shown in Figure 3. From the intercomparison, item 1 gives more stable results in comparison with item 2. This could be due to two different reasons: 1) beam hardening problems arising in CT scanning in presence of multi material objects; 2) a significant form error on the surface of item 2, which influences on the definition of the datums.
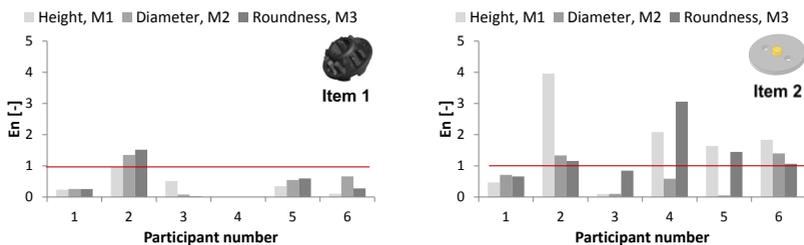
Figure 3: The quality of the measurements from the participants can be judged by calculating the E_n. Hence it is done for the two items and their measurands for six participants through the intercomparison. No data was acquired from participant number 4 for item 1.

4   Conclusions

Preliminary results of a proficiency testing for industrial CT scanners using polymer items were obtained. Stability of the two polymer items was verified over a period of eleven months. It was observed that the polymer items changed over this period of time due to their polymer characteristics. The observations showed a maximum deviation of 33 μm, which was detected for the diameter for item 2. From the intercomparison, item 1 gives more stable results in comparison with item 2. This could be due to a beam hardening caused by multi materials and a significant form error on the surface of item 2.

Acknowledgements

References:

[1] De Chiffre L., Hansen H. N., Morace R. E., Comparison of CMM using an optomechanical hole plate, CIRP Ann. 54, pp. 479-482, 2005.

[2] Carmignato S., Pierobon A., Savio E., First international intercomparison of computed tomography systems for dimensional metrology, Proc. of 11th Euspen int. conf.; Como, Italy, 2011.

[3] ISO TS 15530-3:2002, Geometrical Product Specifications (GPS), Coordinate measuring machines (CMM): Technique for determining the uncertainty of measurement, Part 3: Use of calibrated workpieces or standards.

[4] ISO/IEC 17043:2010, Conformity assessment, General requirements for proficiency testing.