Considerations on numerical modelling for compensation of in-process metrology in manufacturing - DTU Orbit (11/08/2019)

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The growing demands for quality and flexibility and at the same time production speed challenges conventional metrology. The future tendency is that metrology is an integrated part of the production line and thus is placed in a production environment. This is a challenge since dimensional metrology in a production environment might lead to higher uncertainties due to dynamic variations both in the conditions of the environment and in the conditions produced parts, with all the influencing factors such as temperature, vibrations, forces and humidity etc. that lies outside the requirements from today's standards referring to 20°C and 0 N (zero forces acting on the part). However, many of these effects can be treated as systematic errors if the physical phenomena leading to the deviations can be described. Today, it is very common to compensate for the variations in temperature in a classical 1D manner where a measurand is compensated via the coefficient of thermal expansion (CTE) and the difference from the reference temperature. However, when temperature gradients and very complex part geometries exist the deformation pattern might not at all follow a linear path. Instead, more advanced three-dimensional thermomechanical numerical models should be used for predicting the deformation of the parts due to the thermal effects taking the inherent build-up of residual stresses and warpage into account. The same goes for other effects that might change the dimensions over time such as hygroscopic swelling (for polymer parts), which can be taken into account by considering numerical modelling. In the present work, different academic and industrial parts will be used as cases in order to show the advantages of using numerical simulation tools for compensation of the dynamic changes and further also highlight and discuss where the classical 1D approaches might be sufficient for a desired uncertainty.

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