Dynamic Length Metrology (DLM) for measurements with sub-micrometre uncertainty in a production environment - DTU Orbit (12/01/2019)

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Conventional length metrology for traceable accurate measurements requires costly temperature controlled facilities, long waiting time for part acclimatisation, and separate part material characterisation. This work describes a method called Dynamic Length Metrology (DLM) developed to achieve sub-micrometre accuracy on metal parts, or micrometre accuracy on polymer parts, directly in a production environment. The method consists in the simultaneous measurement of all quantities affecting dimensions of a part over time (dynamically), involving a number of sensors and reference artefacts, followed by mathematical or numerical modelling of the thermo-mechanical effects. It is hereby possible concurrently to predict condition-specific material properties as well as part dimensions at any point, time, temperature, humidity, etc. Knowing all systematic errors and influencing factors, and their combined effect, on a given length, it is possible to calculate the corrected length at 20°C, zero measuring force, etc. An estimation of the measurement uncertainty U can be obtained following the guidelines of the GUM, dimensional values and their uncertainties being the final result of the analysis. Preliminary investigations have indicated that the approach is viable, either using analytical modelling or FEM. An expanded uncertainty (k=2) lower than 0.4 μm was achieved using a steel gauge block as workpiece.