Modelling of the influence quantities

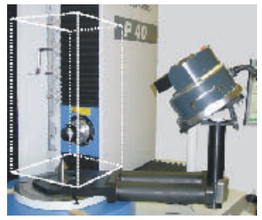
It is of fundamental importance for the reliability of the VCMM-Gear that all quantities having a significant influence on the measurement are modelled close to reality. Examples of the modelling of the important influence quantities are presented in the table below.

Determination of the influence quantities

The traceable determination of the respective amounts and variation ranges of all significant influence quantities is indispensable for the individual applicability of the VCMM-Gear. Examples of the determination of important influence quantities are presented in the table below.

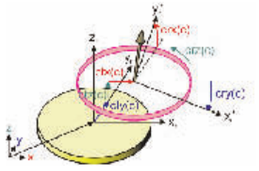
Geometry errors of a (gear) measuring machine

Kinematic error model with 21 geometry deviation components



Use of the LaserTracer applying the multilateration principle

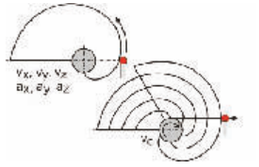
Geometry errors of the rotary table



6 geometrical deviations
- 2 eccentricities
- 1 position error
- 2 wobble errors
- 1 axial error

Use of a ball plate applying the three-rosette method

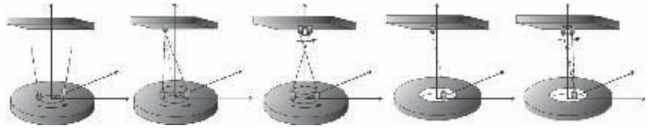
Scanning (dynamical behaviour)



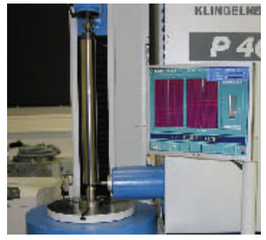
Accelerating direction a_x, a_y, a_z and velocity of the
- rotatory axis v_c
- translatory axes v_x, v_y, v_z

Use of the scanning-artifact (involutely shaped standard)

Clamping



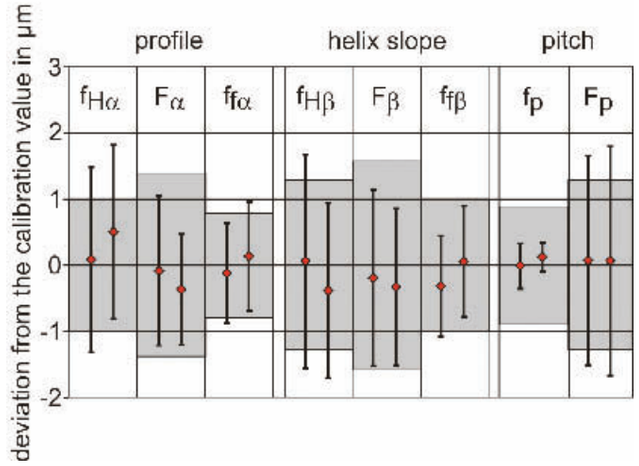
Additional deviation contributions of the rotary table by acting eccentricities (clamping device and workpiece)



Information of the manufacturer and the design drawing

Verification

For a verification of the procedure, profile and helix slope measurements as well as pitch measurements were performed on calibrated gear standards both at PTB and at different industrial companies.



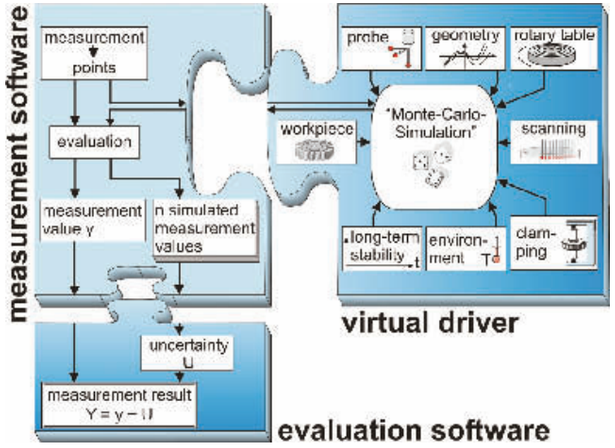
Extract from results of the comparison measurement

The diagram shows
- two representative results each of the profile, helix slope and pitch measurements
- deviations of the measurement values from the calibration value
- error bars which represent the measurement uncertainties $U(k = 2)$ calculated by the VCMM
- respective uncertainty of the calibration as grey shaded areas around the zero line

The results fulfil the condition that the deviations of the measurement values from the calibration values must lie within the calculated measurement uncertainty. The results can be considered as a first reliable verification.

Principle of the VCMM-Gear

Together with the *Forschungsvereinigung für Antriebstechnik e. V.* the PTB has worked on a project to develop an industrially compatible procedure for the determination of the measurement uncertainty in gear metrology. The basic principle of the VCMM-Gear is the replication of the measurement process by simulation. Computer-based, a statistically sufficient large number of measure-ments is performed under realistically changing measurement conditions on a workpiece.



Principle of the VCMM-Gear

Virtual driver

- communication with measurement software via interface (exchange of measurement points)
- multiple randomization of the measurement points on the basis of the modelled influences
- independent from the measurement software includable

Measurement software

- recording of the measurement points
- calculation of the measurement values

Evaluation software

- Calculation of the uncertainty by statistical evaluation of the simulated measurement values

Contact

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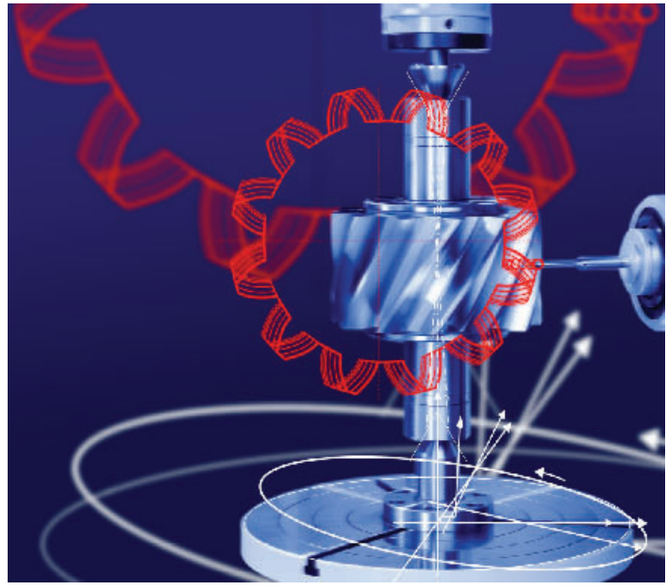
Physikalisch Technische Bundesanstalt

Braunschweig und Berlin

Determination of the Measurement Uncertainty in Gear Metrology

The VCMM-Gear



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