

New Knowledge-based Measurements in Precision Engineering

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ABSTRACT

Aim of the paper is to show practical examples for the definition and application of metrological, particular and virtual objective measurement standards (reference standards) in e-measurements for the solution of complex measurement tasks. The measurement object is a hob with 17 characteristic measurement quantities in shape and position. As a result of e-measurements in a closed e-quality loop the process capability is better than the machine capability.

Keywords: Plain measurements, complex measurements, e-measurements, e-quality management.

1. PLAIN MEASUREMENTS

Plain measurement is defined as the direct or indirect comparison of a measurement object with a metrological measurement standard (reference standard).

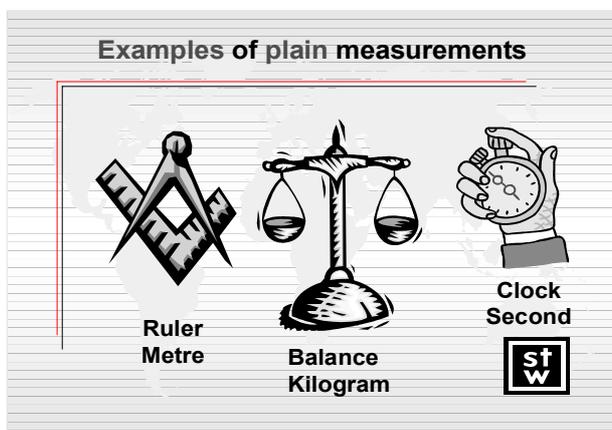


Figure 1 Plain measurements

SI based metrological standards are e.g. etalons for m, kg, s, A, K, mol, cd. Details see in the Web Sites of www.ptb.de, www.bipm.org, www.nist.gov (Fig 1).

2. COMPLEX MEASUREMENTS

Complex measurement is defined as direct or indirect comparison of a measurement object with different measurement standards (reference standards) like:

- metrological (etalons)
- particular (material pattern, master tools, gauges)
- virtual objective (simulation programs)
- virtual subjective (experience).

Complex measurements nowadays are accomplished as e-measurements (Fig 2).

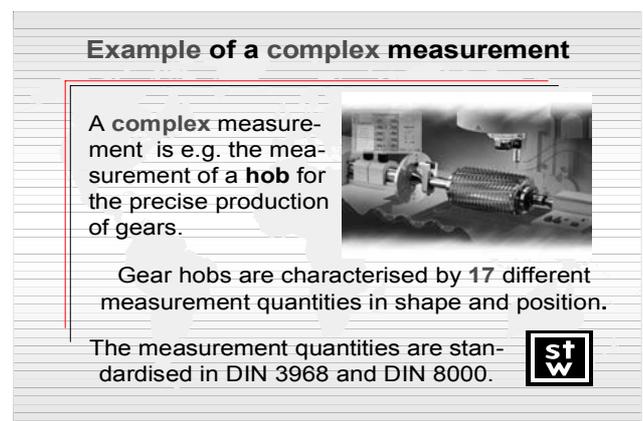


Figure 2 Complex measurements

A **particular** measurement standard (Fig 3) is an objective material pattern intended

- to define,
- to represent material,
- to conserve
- to reproduce

the identification marks of an object or an event in order to transmit it to other measuring objects by comparison.

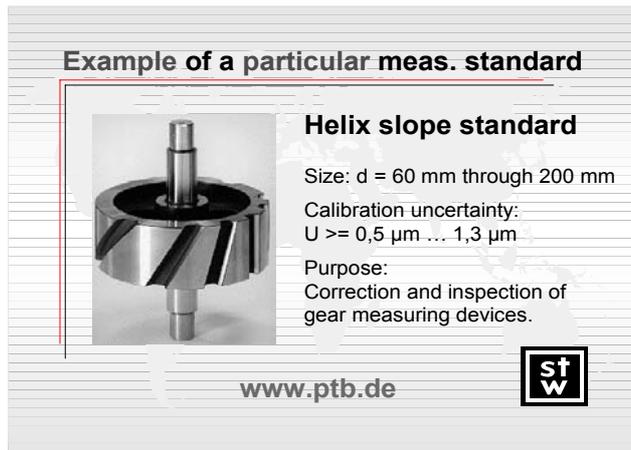


Figure 3 Example for a particular standard

A **virtual objective** measurement standard (Fig 4) is a non-material pattern e.g. a numerical, textual or graphical one like a software program or a data base intended

- to define,
- to represent non-material
- to conserve
- to reproduce

the definition signs of an object or an event in order to transmit it to other measuring objects by comparison.

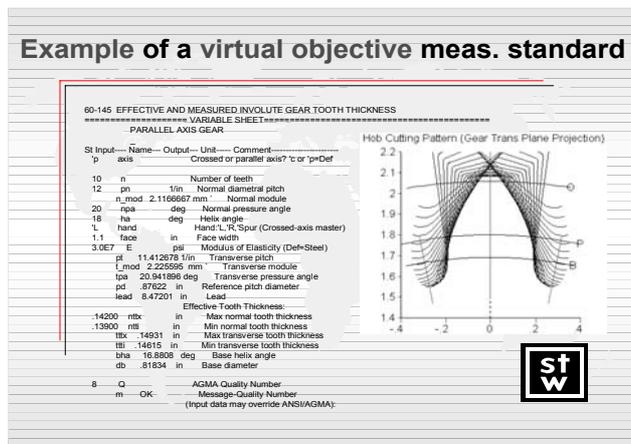


Figure 4 Example for a virtual objective standard

The application of virtual objective measurement standards (reference standards) is increasing due to the fact that they are

- functional better,
- individual more convenient and
- financial affordable

in comparison with material patterns in Net-environments.

3. E-MEASUREMENTS

E-Measurement is the comparison of **unknown** parameters of a measurement object with the **known** parameters of a measurement standard using NET-

technologies for measurement value acquisition and measurement information processing. An example are hobs, which are high precise tools for manufacturing of gears (Fig 5 to Fig 9).



Figure 5 Hobs (www.saazor.de)

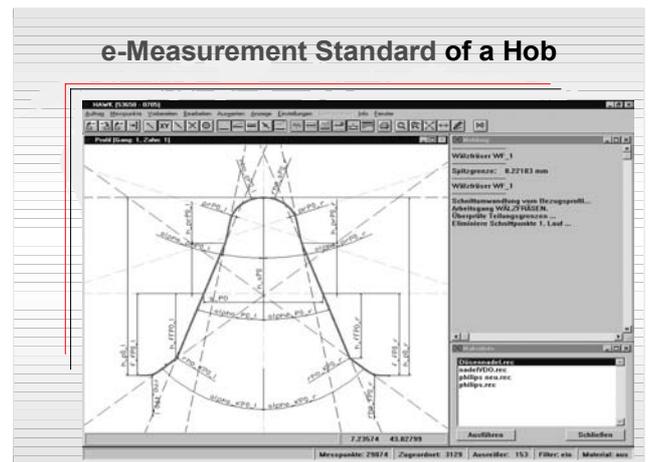


Figure 6 Virtual objective reference standard of a hob (www.esco-aachen.de)

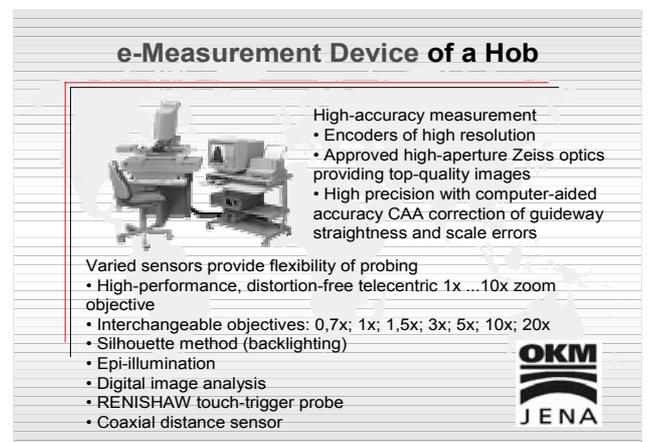


Figure 7 Optical coordinate measurement machine ACCURE with multi sensor system (www.okm-jena.de)

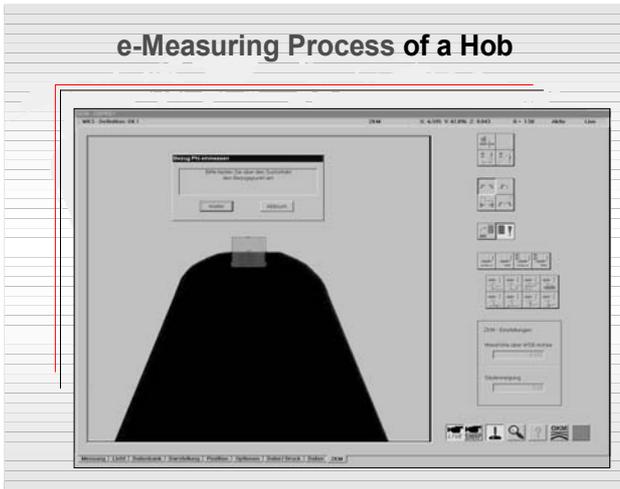


Figure 8 Optical e-measuring processes (www.okm-jena.de)

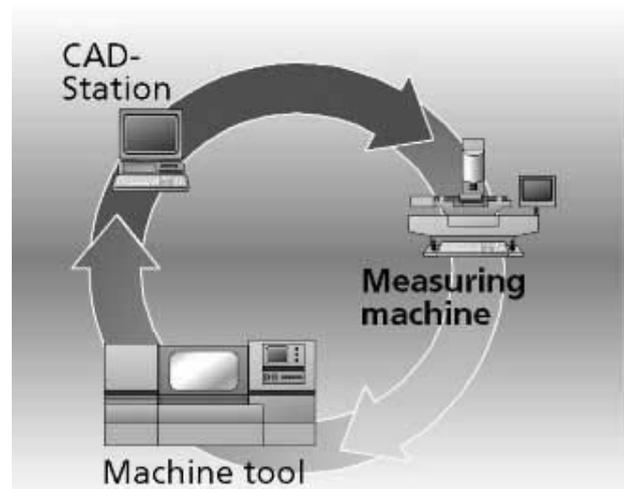


Figure 10 Closed quality loop with e-design, e-manufacturing and e-measurement (www.okm-jena.de)

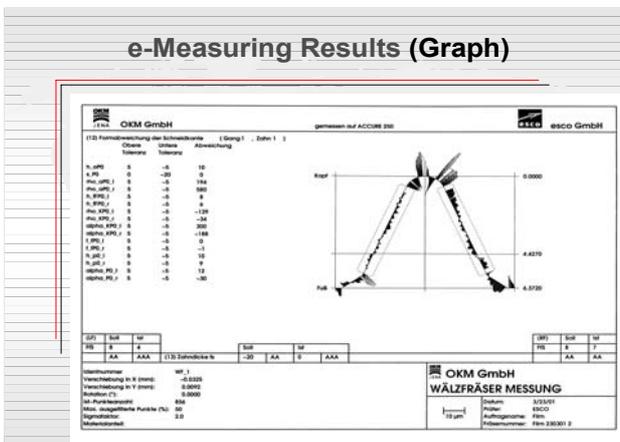


Figure 9 E-measuring results for a hob profile (www.esco-aachen.de + www.okm-jena.de)

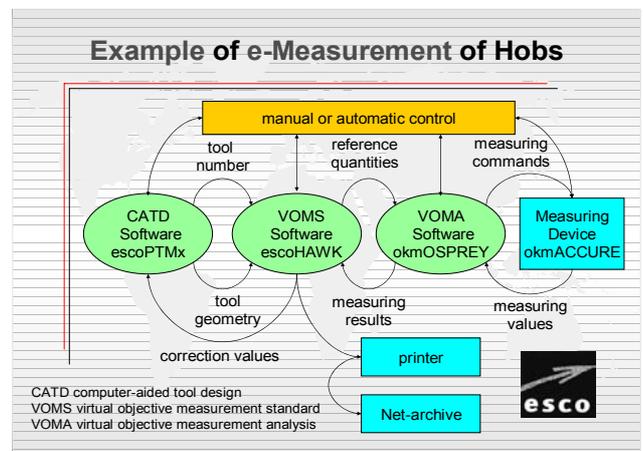


Figure 11 Block diagram of complex e-measurement of hobs (www.esco-aachen.de)

4. E-QUALITY MANAGEMENT

A new paradigm in e-quality management is the knowledge-based two step method of e-manufacturing and e-measurement in a closed e-quality loop with **1st step:** E-manufacturing of the tool and e-measuring of the **unknown** quality parameters.

2nd step: E-Controlling of the machine tool with the **known** deviations of the 1st step.

Result: The process capability is better then the machine capability (Fig 10 to Fig 12).

The classical one dimensional understanding of real-time procedures should be complemented by a new three dimensional understanding of timeliness on demand. That means for manufacturing, measuring and control that the information concerned must be available in a standardised Net

- Everytime and
- Everywhere on
- Every device.

The new paradigm is discussed in www.real-time.org and www.microsoft.net.

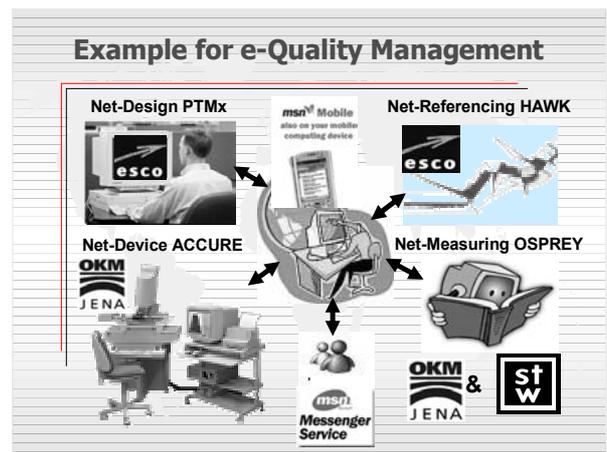


Figure 12 Practical realisation of complex e-design and e-measurement of hobs

New possibilities for engineered solutions increase quickly under the influence of the convergence of office and plant automation (Ethernet and Industrial Ethernet), wireless communication (Bluetooth, UMTS and Internet) and standardised operation systems (Windows XP + PC). PC stands for Pocket Computer.

5. CONCLUSIONS

Quality, reliability and profit in machine building and precision engineering depend entirely on components being manufactured to dimensions or tolerances in the micron or even nanometric range. These ranges are outside of the 6 sigma range of standard machine tools in plant floors. The new paradigm for precision manufacturing is e-quality management with e-design, e-manufacturing, e-measurement and e-control on the basis of ubiquitous standardised Net-technologies. The given example is typical for up-to-date hob production.

6. REFERENCES

see Hyperlinks