Principles of traceability in coordinate metrology

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Keywords: CMM, traceability, uncertainty

Traceability is essential to compare measurement results and to match fitting parts individually measured with different instruments. Specifically, it is for coordinate measurements in globalized manufacturing. Unfortunately, traceability is particularly difficult to achieve in coordinate measurements. The distinctive and very valuable CMS's feature of flexibility and universality makes the paths to traceability resemble more a maze than a highway. CMS's cannot be calibrated once for all simply because this should be done separately for all possible measurement tasks, which are virtually infinite in number and variety. Standardised tests (such as those in the ISO 10360 series [1]) are primarily aimed at promoting the CMS commerce and at the metrological reverification: they help but are insufficient for ensuring traceability. Material standards – either calibrated or working standards – are a possible solution, at the cost though of spoiling the peculiar universality of CMS's. Because of this difficulties, the accreditation infrastructure in this field is not as developed as in others: most geometrical measurements are unique in their geometry, unlikely to be covered by the accreditation of calibration or testing laboratories.

The NMI's (National Metrology Institutes) sit at the apex of the traceability pyramid; they calibrate top level standards and start the traceability chain. In view of the above-mentioned lack or accredited laboratories, they also calibrate lower level standards in selected cases when documented traceability is required. In either case, the traceability problem must be solved in the calibration. For the NMI's, the usual pressure in industry on cost and time is much relieved; on the other hand, the requirement on metrological rigour is much exacerbated.

A general procedure has been prepared and validated at INRIM for calibrating standards virtually of any geometries. It is based on extending the traceability of auxiliary calibrated standards of simple geometry to the required complex geometry by means of a CMM. It is the adaptation and extension of the well-known comparator principle to coordinate metrology. Relieved from the burden of traceability, the CMM flexibility is fully exploited to manage the geometries at hand.

[1] ISO 10360 Geometrical product specifications (GPS) – Acceptance and reverification tests for coordinate measuring systems (CMS) (*Parts 1 to 12, 2000-2016; Part 11 and 13 under development*).