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Review

Eric R. Marsh
Precision Spindle Metrology
DEStech Publications, Inc., Lancaster, USA, 2008.
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Prof. Marsh is at the Penn State University Mechanical Engineering faculty working in the field of precision engineering.

His book “Precision Spindle Metrology” (161 pages) starts with a case study of a CNC lathe demonstrating effects of spindle error motions to a turned workpiece. This is followed by a brief history of spindle testing, starting with Schlesinger and Tlusty and ending with ASME B89.3.4 standard “Axis of Rotation”, which is basis for definitions and expressions used in the book.

Therefore the book opens the world of axial, radial, tilt and face error motion (instead of runout), influence of the structural loop, fixed and rotating sensitive direction, average and asynchronous error motion, and thermal drift. Excellent figures help in understanding these error motions and differentiations as well as their effects on a workpiece.

Two chapters are dedicated to testing spindles and data analysis, which is mainly based on Lion Precision’s spindle tester (Lion holds the copyright of the book together with Precision Instruments). Environmental effects, aliasing effects, analogue-to-digital conversion and filtering are clearly explained, again supported with instructive figures.

As precision spindles are targeted in this book, reversal techniques (Donaldson reversal, face error motion reversal, multi-probe error separation, multi-step error separation, Grejda reversal, master axis reversal) are described and explained in detail in order to separate spindle errors from artefact errors in the sub-micrometer range.

Case studies show the application of all the theory on a surface grinder, a CNC turning centre, a CNC machining centre, and a CNC diamond turning machine. The last chapter applies the theory on tapered roller bearing spindles, giving information on instrumentation for rolling element bearings, and the repeatability of such bearings and of ball bearings. Furthermore air bearing stiffness and pressure, and gas compositions and asynchronous error are discussed.

157 references, starting in 1873 (Maxwell) and ending in 2006, covering axis of rotation measurement, roundness measurement, error separation technique, influence of temperature, measurement uncertainty, and spindle design, give a good overview of work presented in this field.

Designers of precision spindles and people testing spindles, who want to apply the concept of spindle error motion which is also overtaken by ISO 230-7:2006, Test code for machine tools –

Part 7: Accuracy of axes of rotation, will be supported by this book. The book also shows how to move measurement uncertainty to new levels by applying error separation techniques correctly, and gives insight into design of precision spindles.

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