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MANUFACTURING THE FUTURE CONFERENCE 2013

Towards obtaining robust boundary condition parameters to aid accuracy in FEA thermal error predictions

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Finite Element Analysis (FEA) is used as a design tool within engineering industries due to the capability for rapid summative analysis accompanied by the visual aid. However, to represent realistic behaviour, FEA relies heavily on input parameters which must ideally be based on true figures such as data from experimental testing which sometimes requires time-consuming testing regimes. In the case of machine tool assemblies where complex structural joints and linkages are present, access to those areas can be a primary constraint to obtaining related boundary parameters such as heat flow across joints, for which, assumptions are incorporated to the FEA model which in effect increase the uncertainty in the FEA predictions. Similarly, in the case of thermal error modelling, simplifications are made when representing thermal boundary conditions such as the application of a uniform convection parameter to an assembly with parts assembled in both horizontal and vertical orientations. This research work aims to reduce the number of assumptions by providing experimentally obtained thermal boundary condition parameters. This work acknowledges experimental regimes that focus on obtaining thermal parameters related to the conduction across assembly joints (Thermal Contact Conductance-TCC) and measures the convection around areas such as belt drives and rotating parts to obtain convection parameters as inputs to the FEA. It provides TCC parameters for variable interfacial behaviour based on the varying contact pressure and the heat flow through dry and oiled contacts such as the conduction from spindle bearings to the surrounding housing and conduction from guideways into the associated assembly through carriages and contact bearings. It provides convection parameters across the test mandrel rotating at different speeds and around stationary structures such as convection parameters observed during TCC tests. It also provide details on the methods used to obtain all these parameters such as the use of thermal imaging, sensors placements and methods to obtain these boundary condition parameters. The significance of this work is to improve dramatically FEA thermal predictions, which are a critical part of engineering design. Although the focus is on machine tool design, the process and parameters can equally be applied to other areas of thermodynamic behaviour.

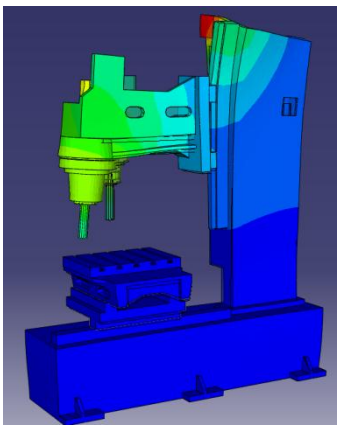

Figure 1: FEA model of a machine tool showing temperature gradients

*denotes required fields