Internal Traverse Grinding – From Single Grain Models to Macroscopic Process Simulations

R. Holtermann[♮*], **A. Menzel**[♮†], **S. Schumann**[‡], **D. Biermann**[‡]

[♮]Institute of Mechanics, TU Dortmund, Leonhard-Euler-Str. 5, 44227 Dortmund, Germany,
raphael.holtermann@udo.edu, andreas.menzel@udo.edu, http://www.iofm.de

[†]Division of Solid Mechanics, Lund University, P.O. Box 118, SE-22100 Lund, Sweden,
http://www.solid.lth.se/

[‡]Institute of Machining Technology, TU Dortmund, Baroper Str. 301, 44227 Dortmund, Germany,
schumann@isf.de, biermann@isf.de, http://www.isf.de

ABSTRACT

We present recent advances in the modelling and simulation of Internal Traverse Grinding with electroplated cBN wheels, a novel manufacturing process that is capable of performing a high rate of material removal while maintaining a good surface quality of the finished cylindrical part. The major drawback of this process is a highly concentrated thermal load on the workpiece which can result in metallurgical changes of the latter, such as, e.g., white layers, cf. [1]. To model the complex material removal of the underlying process, a simulation framework consisting of three major components is under development.

The first component is a kinematic simulation that is based on a topography analysis of measured grinding wheel surfaces. It models the entire grinding wheel as Constructive Solid Geometry and sections of the workpiece as a radial dexel board. In this way, we calculate the transient penetration history of every cBN grain on the grinding wheel as well as histograms characterising the frequency distribution of certain grain-workpiece interactions. Based on these histograms, the input parameters for a series of representative single-grain simulations, which constitutes the next framework component, are determined.

The second framework component is a parametric, thermo-mechanically coupled, h-adaptive finite-element-simulation on a meso-scale that captures the proximity of a single cBN grain being in contact with the workpiece bulk, cf. [2]. With these meso-scale results at hand, namely cutting forces and heat energy generated in the workpiece, one needs to transfer these to the process scale. This task is accomplished by a recently developed interpolation scheme which combines results from both of the above-mentioned simulations.

The results gained from this interpolation scheme are then used as boundary conditions for the third component of the simulation framework, namely a process model on the macro-scale which will in the near future be used to predict the thermo-mechanical response of the workpiece during grinding and shall be used to develop compensation strategies to minimise manufacturing errors and improve the overall efficiency of the process. To be able to fulfill this high objective, experimental investigations are carried out to validate the results of the simulation framework under development.

REFERENCES

[1] K. Marschalkowski, D. Biermann and K. Weinert, "On the Characteristics of High-Performance Internal Traverse Grinding Using Electroplated CBN Wheels", *Proceedings of the 4th CIRP International Conference on High Performance Cutting CIRP HPC*, **1**, 393-398 (2010)

[2] R. Holtermann, S. Schumann, A. Menzel and D. Biermann. "Modelling, simulation and experimental investigation of chip formation in internal traverse grinding", *Production Engineering - Research and Development*, **7**(2-3), 251-263 (2013)