Simulation of tool wear in hard turning

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Abstract

In the last decades the analysis of machining processes, the development of new cutting materials and tool geometries led to an astonishing productivity of machining operations. High performance technologies such as dry, hard and high speed machining became state of the art. The actual challenge is to improve the process productivity by the reduction of tool wear and improvement of the workpiece properties. To combine the right machining operation, workpiece material, tool material and geometry, coating and lubrication strategy a deep understanding of the cutting process is necessary. This can be realized by modeling the hard turning process by means of the Finite Element Method (FEM), which considers the chip formation as well as the tool wear. Therefore an approach for the calibration of a tool wear model and its implementation in an user-subroutine of an existing FEM model of the hard turning process is presented. The calibration procedure is divided into an experimental part and a simulation part. In the experiments, the tool wear evolution of cBN-inserts cutting a case-hardened steel has been documented. Parallel, the thermal-mechanical tool load has been simulated using the Finite Element Method. Next, the results from the experiments and the simulation will be combined and the material dependent constants from the tool wear model will be determined using the method of regression analyses. The overall aim is to simulate quantitatively tool wear in hard turning. Therefore the tool geometry has to be modified considering its thermo-mechanical load and the resulting tool wear. The approach enables to clarify the influence of cutting forces, temperatures and chip formation on tool wear in hard turning the case hardened steel 16MnCr5 with cBN inserts.