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AN ORIGINAL INVERSE METHOD FOR CHARACTERIZATION OF HEAT FLUX IN GRINDING

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ABSTRACT

During a manufacturing process, the integrity of the surface can be modified in many ways: burns, hardening, residual stresses …With the grinding process, the most important induced effect is the generation of heat which can leads to high temperatures. In order to model the apparition of grinding effects, the knowledge of these temperatures is needed for each condition of grinding. Actually, in order to simulate by finite elements simulation, the major issue is the estimation of the heat flux entering the workpiece. In previous work such as Malkin [1] or Rowe [2] the value and shape of this flux is often assumed to be triangular with a power given by a partition of the whole absorbed power. Even if this first approach can give quite good results compared with temperature values measured by thermocouples, it is important to be careful and be sure of the distribution of these temperatures. Indeed, the integrity of ground surface is not only the consequence of the maximum absolute value of the temperature reached in the workpiece but the thermal history and mainly the heating and cooling rate are very important for the apparition of residual stresses and phase change.

In order to have a good accuracy of this heat flux and the induced temperatures obtained a new method for its characterization is proposed. Its principle is an inverse method based on the measurement of temperature and numerical simulations. In this way the temperature distribution is measured using an infrared camera and the main goal of the inverse method is to find the heat flux value and shape that gives the best match between numerical and experimental temperature fields [3]. For this optimization process a classic Gauss Newton algorithm is used as well as a stochastic method [4]. The comparison of these two methods is very interesting for the full understanding of the optimization algorithms. Indeed, if the stochastic seams to be more stiff and ensure the determination of a global minimum, this random-based method needs many parameters to be determined. On the other side, the Gauss Newton algorithm is a lot more objective iterative process which ensures the repeatability of the solution found. Unfortunately this gradient-based method turns out to be very sensible to noise and needs improvement for a better accuracy. Methods like "line search" or initial conditions optimization have then been tested and compared.

Finally this paper presents different methods to obtain the optimized three parameters of the heat flux shape entering the workpiece during grinding. The main topic of the paper is to detailed the two methods developed and compared them for the stiffness, reliability, rightness… of the solution. Finally, the choice of the method parameters is explained and an example on real grinding conditions is proposed.

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