ANALYTICAL MODELING OF SURFACE INTEGRITY - RECENT TRENDS AND ADVANCES-

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Abstract: *The fast technological development generated an acute need for high quality machined components, especially in the automotive industry. During the past few years, researchers all over the world focused on creating theoretical models for different surface integrity (SI) parameters. These models are extremely important because they allow the prediction of the real values of the SI parameters, thus enabling the computer aided process planning and, at the same time offer a reduction of machining time and costs. The present paper offers a review of the recent trends and advances in analytical modeling of surface integrity parameters: roughness, residual stresses and microstructural alterations.*

Keywords: *analytical modeling, surface roughness, residual stresses, microstructural alterations*

1. Analytical modeling of surface roughness

Rapid technological development created the need for high quality machined components, especially in the automotive industry. One of the main aspects that characterize this quality is surface roughness. During the past fifty years, researchers all over the world focused on creating theoretical models for assessing the surface roughness of machined components. Determining the theoretical value of this parameter, for a certain machining operation, is extremely important for engineers, as it allows the prediction of the real value and enables the computer aided process planning.

According to Benardos şi Vosniakos [1], who wrote o comprehensive review of the research work in this field, the surface roughness modeling procedures and techniques can be devised into four categories: analytical models, experimental methods, design of experiment (DoE)- based methods and artificial intelligence (AI)- based methods.

In analytical modeling, the estimation of the theoretical value of surface roughness is based on the relative motions that characterize the respective machining process and on the geometry of the cutting edge. This method was used by Ehmann and Hong [2] to develop the so called "Surface Shaping System", a model so complex that it can basically be applied to any type of single- and multipoint tool, and that, in addition, takes into account the higher order motions (vibrations, cutting tool run- out etc.). Likewise, this modeling technique was used Franco [3], Baek et al. [4], Kim and Chu [5], Felho and Kundrak [6] and others.

One of the several different parameters used to describe the deviation of a surface from an ideal level is the arithmetic mean surface roughness (R_a). By analyzing the published literature, it is obvious that there are very few equations that describe the influence of different process parameters on R_a. More often than not, the research papers offer equations based on numerical adaptions of experimentally obtained values [7, 8, 9, 10]. Generally, in practice, the maximum theoretical surface roughness (R_{max}) is calculated for given values of the cutting data. By correcting the R_{max} value through a factor ranging from 3- 4 (based on experience), an estimation of the R_a parameter can be obtained