

A New Model and Analysis of Orthogonal Machining With an Edge-Radiused Tool

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A new machining process model that explicitly includes the effects of the edge hone is presented. A force balance is conducted on the lower boundary of the deformation zone leading to a machining force model. The machining force components are an explicit function of the edge radius and shear angle. An increase in edge radius leads to not only increased ploughing forces but also an increase in the chip formation forces due to an average rake angle effect. Previous attempts at assessing the ploughing components as the force intercept at zero uncut chip thickness, which attribute to the ploughing mechanism all the changes in forces that occur with changes in edge radius, are seen to be erroneous in view of this model. Calculation of shear stress on the lower boundary of the deformation zone using the new machining force model indicates that the apparent size effect when cutting with edge radiused tools is due to deformation below the tool (ploughing) and a larger chip formation component due to a lower shear angle. Increases in specific energy and shear stress are also due to shear strain and strain rate increases. A consistent material behavior model that does not vary with process input conditions like uncut chip thickness, rake angle and edge radius can be developed based on the new model.