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# 2nd International Conference on Materials Manufacturing and Design Engineering

# $Drilling of Aluminium 6061 allows$ Drilling of Aluminium 6061 alloy Modelling, Simulation and Experimental validation of Burr size in  $M_{\text{m}}$  of Modelling, and  $M_{\text{m}}$

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## **Abstract**

*Unochapecó, 89809-000 Chapecó, SC, Brazil*  Precision manufacturing gained much importance in manufacturing industries in the recent past. Drilling process takes place in often lowers the surface quality, reduces the product life. The model works through an energy balance equation which finds the process parameters, it can be minimized. The present work aims at developing a mathematical model for burr formation in drilling operation. Thereby validating these models, experiments are conducted by varying different process parameters. The values obtained from experimentation are compared with simulated results developed in Deform™-3D. all manufacturing processes and influences the acceptability of the products, as the drilling is at the most final processing stage in point at which the downward cutting force of the drill is equivalent to the force required to plastically deform the remaining material underneath the drill into a burr. Elimination of burrs during drilling is a trivial task however, with proper selection of the production line. The burr, which is a plastically deformed material, generated during drilling is an unnecessary output and

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Section the Additions. Fubrished by Eisevier B.V.<br>Peer-review under responsibility of the scientific committee of the 2nd International Conference on Materials Manufacturing and contributions from both the practical and theoretical perspectives. This paper presents and discusses a mathematical Design Engineering. r cer-teview under responsionity of the setemme commutee of the 2nd international conference on Material<br>Design Frigineering *Keywords: Burreformation, Thrusteen Burreformation, Thrusteen Burrel and Twitterstand*, Burrel and Twitterstand, Thrusteen December 2004, Thrusteen December 2004, Thrusteen December 2004, Twitterstand, Thrusteen December r cerver under responsionly of the scientific commutee of the 2nd international conference on Materials Manufacturing and<br>Design Engineering

model for capacity management based on different costing models (ABC and TDABC). A generic model has been different costing models (ABC and TDABC). A generic model has been different costing model has been different costin Keywords: Burr formation, Thrust force, Taguchi Method, FEA, Deform<sup>™</sup>-3D software

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#### $\overline{a}$  operation might hide operation might hide operation  $\overline{a}$ © 2017 The Authors. Published by Elsevier B.V. **1. Introduction**  $\frac{1}{\pi}$  in contraduction in cost and time to predict parameters such as stresses, stresses, thrust and temperature  $\frac{1}{\pi}$

Nowadays, 3D modelling of the metal cutting processes is a more popular technique [1]. The main advantage of this technique is reduction in cost and time to predict parameters such as stresses, strain rates, thrust and temperature

value. The trade-off capacity maximization vs operational efficiency is highlighted and it is shown that capacity

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 $y_1$  initiation height

were very difficult to found experimentally[2,3]. Especially, 3D finite element analysis show a significant advantage compared to other approaches to predict burr geometry [4] during metal cutting process. Present work carried out to accentuate the importance of 3D modelling of the drilling processes and to demonstrate its advantages. [5, 6] presented an overview of a two dimensional FEM code used by DEFORM to study orthogonal cutting. They detail many of the topics discussed in this paper but applied in two dimensions. His analysis is also applied toward orthogonal cutting as opposed to three dimensional drilling. Klocke et al. detail much of the basic FEM theory and machining theory embedded in DEFORM's code. One key advantage of then Lagrangian mesh in simulating drilling processes is the ability to know the entire time history of the key variables at every point during the simulation. That means, if a simulation crashes for any reason, a new simulation can start where the crashed simulation stopped. This is particularly useful because nearly every simulation has some sort of problem during the run. This is possible because the Lagrangian mesh is reformulated at nearly every time step, in order to manage the deformation of the material. One of the biggest strengths of DEFORM is its ability to mesh complex geometries. Significant deformation occurs in machining simulations and this has been historically problematic for the Lagrangian mesh. However, if the geometry is remeshed after each time step, the Lagrangian mesh is a reasonable choice to show burr formation. DEFORM is a leader in creating adaptive meshes and remeshing complex geometry and this makes it a desirable code for drilling analysis. One of the biggest strengths of DEFORM is its ability to mesh complex geometries. Significant deformation occurs in machining simulations and this has been historically problematic for the Lagrangian mesh. However, if the geometry is remeshed after each time step, the Lagrangian mesh is a reasonable choice to show burr formation. DEFORM [7] is a leader in creating adaptive meshes and remeshing complex geometry and this makes it a desirable code for drilling analysis.

## **2. Modeling and Simulation**

## *2.1 Analytical Modeling*

Burr formation model (Fig.1) originally depends on the stress and strain rate of the material flow at the end of the cut has to be analyzed in the finite element method. The finite element analysis (FEA) is effective to understand the material behavior in the process [8, 9, 10]. However, it has not yet been applied to the design of the drill geometry and takes a long time for the simulations. Other analytical models, therefore, is required to optimize the geometry in the drilling operation. An analytical model is developed by integrating by John-Cook coupled and Sofrona's model to predict the thrust force and burr height in drilling process.

From dimensions of geometry of twist drill 'q' value obtained, after that using metal cutting principles and theory of plasticity derived the following equations and found normal rake angle, drill friction amgle.

$$
\tan \theta = \frac{(1 - q^2 \sin^2 \beta) \tan \delta}{\sqrt{(1 - q^2)} \sin \beta} - \frac{(q \cos \beta)}{\sqrt{(1 - q^2)}}
$$
  
Where,  $\mu = \frac{\pi}{6} + \frac{\theta}{2}$  and  $q = \frac{\text{web thickness of drill}}{\text{diameter of the drill}}$ 

From John-Cook material flow, Ernst and Merchant equation, shear flow angle calculated as ; f =feed, mm/rev,  $y_1$  = Initiation height of the burr  $\epsilon$ = ratio of drill feed to the initiation height =  $\frac{f}{2v}$ 

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