CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
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Project Number
S0208

Project Title
The Effect of Differing End Mill Length and Diameter on Dimensional Control While Cutting Steel with an End Mill

Abstract

Objectives/Goals
The purpose of the project was to determine the effect of differing end mill length and diameter on dimensional control while cutting steel with an end mill. It is believed that end mills with a small flute length to end mill diameter aspect ratio will have the least deflection. It is also predicted that the deflection will be directly proportional to the flute length to the third power divided by the diamter to the fourth power.

Methods/Materials
Materials: 2 meter steel bars with dimensions of 19.05 mm x 19.05 mm; End mills of 1.59 mm, 3.18 mm, 4.76 mm, and 6.35 mm diameters with ratios of flute length to diameter of 2.0, 3.0, 3.3, 4.0, and 6.0; CNC End Mill; Band Saw; Safety Goggles; Deburring Paper; Roughing tool of 12.7 mm diameter; Collet (tool holder); Pre-Setter; Micrometer
A computer numerically controlled (CNC) program was created to cut steel blanks into a desired shape through the use of a finishing tool in a CNC Milling Machine. Ten finishing tools with different combinations of end mill diameter and length were chosen to be tested. Three samples w ere cut for each end mill combination of length and diameter. Using a micrometer, the dimensions at the top (closest to tool holder) and bottom (farthest from tool holder) of the machined parts were taken. The difference of these two values was then taken and divided by two in order to determine the deflection for each individual end mill.

Results
With a mean deflection of 0.00 mm, it was found that the five end mills with a length to diameter aspect ratio below 4 to 1 had the lowest deflection. The five end mills with an aspect ratio greater than or equal to4 to 1 had a higher mean deflection of 0.03 mm. For the experiment, the percent deviation ranged from 0.00% to 0.07%, indicating a high repeatability within the project.

Conclusions/Discussion
It was concluded that the hypothesis which stated that end mills with a smaller aspect ratio would have less deflection was supported. Furthermore, it was concluded that the deflection was directly proportional to the flute length to the third power divided by the diameter to the fourth power, with a correlation coefficient of .864, lending validity to the conclusion.

Summary Statement
Accessing the impact of cutting with end mills of differing flute length and diameter on dimensional control.

Help Received
Brother and Parents gave technical support throughout the project.