EFFECT OF TOOL LENGTH ON PLAIN TURNING PERFORMANCE

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A project report submitted in partial fulfillment of the requirements for the award of the degree of Master of Engineering (Mechanical - Advanced Manufacturing Technology)

Faculty of Mechanical Engineering
Universiti Teknologi Malaysia

MAY 2010

To my beloved wife and daughter

To my beloved parents who taught me life by doing

ACKNOWLEDGEMENTS

In the name of Allah, the most Gracious and most Compassionate

I would like to thank Allah Almighty for the blessings and giving me strength to complete this thesis. I am indebted to all who helped directly or indirectly to complete this project report.

Thanks are due to Majlis Amanah Rakyat and Kolej Kemahiran Tinggi MARA Balik Pulau for the financial and facilities support during the period of this research work.

I would like to thank Prof. Dr. Noordin Mohd Yusof (supervisor) and others lecturers in this programme for their valuable experiences, comments, suggestions, guidance and advice throughout the project. There are no doubts that their valuable comments and suggestions have influenced and enhanced this project report.

A special thanks are due to many other individuals and organizations that have been involved with this project in one form or another.

Last but certainly not least, very special thanks are due to my family and friends who supported me from start to finish with their love, support and encouragement are greatly appreciated.

ABSTRACT

The purpose of this research paper is to find a correlation between surface roughness and cutting conditions (cutting speed, feed rate, depth of cut, and tool overhang) especially tool overhang as the output response variable in turning Aluminum Alloy 6061 without using supported (tailstock) and in dry cutting (without coolant). The tool length variable is introduced because to investigate that the vibration generated by varying the tool length could affect the resulting surface finish. Dry cutting (without using cutting fluid) are conducted to stimulate a good turning, provide a clean environment to obtain undisturbed clear cutting vibration, which result in more accurate and clear correlation between cutting condition and surface roughness. Examine the relationship that exists between the length, at a specific diameter, and surface roughness of bar stock in unsupported turning operations in an attempt to reduce setup waste in turning operations. The concept of Design of Experiments (DOE) was used for necessary experimentation. The experimental results were analyzed statistically to study the influence of process parameters on surface roughness. Response surface methodology (RSM) was used for modeling and analysis in applications where a response of interest is influenced by several variables and the objective is to optimize this response under the range of cutting condition been set. The analysis of variance revealed in this study is that feed rate, cutting speed and tool length have significance effects on the surface roughness and the best surface roughness condition is achieved at a low feed rate 0.07 mm/rev, high cutting speed 280 m/min and short tool length 22 mm. The results also show that the feed rate has big effect on surface roughness followed by tool overhang and cutting speed. The depth of cut has not a significant effect on surface roughness in this study.

ABSTRAK

Tujuan kertas kajian ini adalah untuk mencari satu hubungkait antara kekasaran permukaan dan parameter pemotongan (kederasan memotong, kadar suapan, kedalaman potongan, dan juntaian matalat) terutama pembolehubah juntaian matalat dalam melarik Aloi Aluminium 6061 tanpa menggunakan penyokong (stok belakang) dan tanpa bendalir penyejuk. Panjang alat pembolehubah diperkenalkan untuk menyiasat samada getaran yang terhasil daripada pelbagai kepanjangan matalat akan mempengaruhi kemasan permukan bahan. Pemotongan tanpa bendalir penyejuk dijalankan bagi merangsang pemotongan larik yang baik, menyediakan persekitaran potongan yang tidak terganggu oleh bendalir penyejuk dimana hubungkait antara parameter pemotongan dan kekasaran permukaan adalah lebih jelas dan tepat. Ujikaji dijalankan tanpa penyokong (stok belakang) bertujuan mengurangkan pembaziran ketika penyediaan proses pemotongan bahan. Konsep Rekabentuk Eksperimen (DOE) digunakan untuk keperluan eksperimen ini. Keputusan percubaan dianalisis secara statistik untuk mempelajari pengaruh parameter terhadap kekasaran permukaan. Respon Metodologi Permukaan (RSM) digunakan bagi memastikan parameter yang mempengaruhi permukaan kekasaran dan mencari optimum parameter keatas respond dalam julat keadaan pemotongan yang telah ditetapkan. Analisis varian mendedahkan dalam kajian ini kadar suapan, kederasan pemotongan dan juntaian matalat memberikan kesan signifikasi terhadap kekasaran permukaan dan keadaan permukaan berada pada tahap yang baik apabila kadar suapan berada pada keadaan paling rendah iaitu 0.07 mm/rev, kederasan pemotongan pada tahap tertiggi 280 m/min dan juntaian matalat paling pendek 22 mm. Keputusan ujikaji juga menunjukan bahawa kadar suapan merupakan pemberi kesan yang besar terhadap kekasaran permukaan diikuti juntaian matalat dan kederasan pemotongan. Kedalaman pemotongan tidak memberi kesan terhadap kekasaran permukaan dalam ujikaji ini.

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LIST OF ABBREVIATIONS AND SYMBOLS

D, d	-	Diameter
γ	-	Rake Angle
CS	-	Cutting Speed
DOC	-	Depth of Cut
f	-	Feed Rate
l	-	Tool Overhang Length
Ra	-	Mean Roughness
Ry	-	Maximum Peak
Rz	-	Ten-point Mean Roughness
Sm	-	Mean Spacing
t_m	-	Machining times
ANOVA	-	Analysis of Variance
RPM	-	Revolution per Minutes
DOE	-	Design of Experiment
RSM	-	Response Surface Methodology
α	-	Significance Level
CCD	-	Central Composite Design

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CHAPTER 1

INTRODUCTION

1.1 Overview

The advancement of the turning and subsequent modern technologies was made possible through research leading to the development of optimization tables that list specific feed rates, spindle speeds, and depths of cut for different materials. These tables are the standard used in industry as a source of reference, when making a change from one job to another where the machining parameters of each may be quite different. The time, material, and tooling costs associated with the experimental steps needed to find the appropriate machining parameters to eliminate for each new job, giving the company the advantage of a reduction in setup costs and to improved product quality.

In machining of parts, surface quality is one of the most specified customer requirements. There are many parameters such as cutting speed, feed rate, and tool nose radius that are known to have a large impact on surface quality. However, there are many more parameters that have an effect on the surface roughness, but those effects have not been adequately quantified. In order for manufacturers to maximize their gains, an accurate model must be constructed of the process. Several different statistical modeling techniques have been used to generate models, including regression, surface response generation, and Taguchi methods. Though many attempts have been made to generate a model, these current models only describe a small subset of the overall process. Future work is still required to create a model that generates an accurate prediction of surface quality and gives manufacturers a robust, efficient machining process.

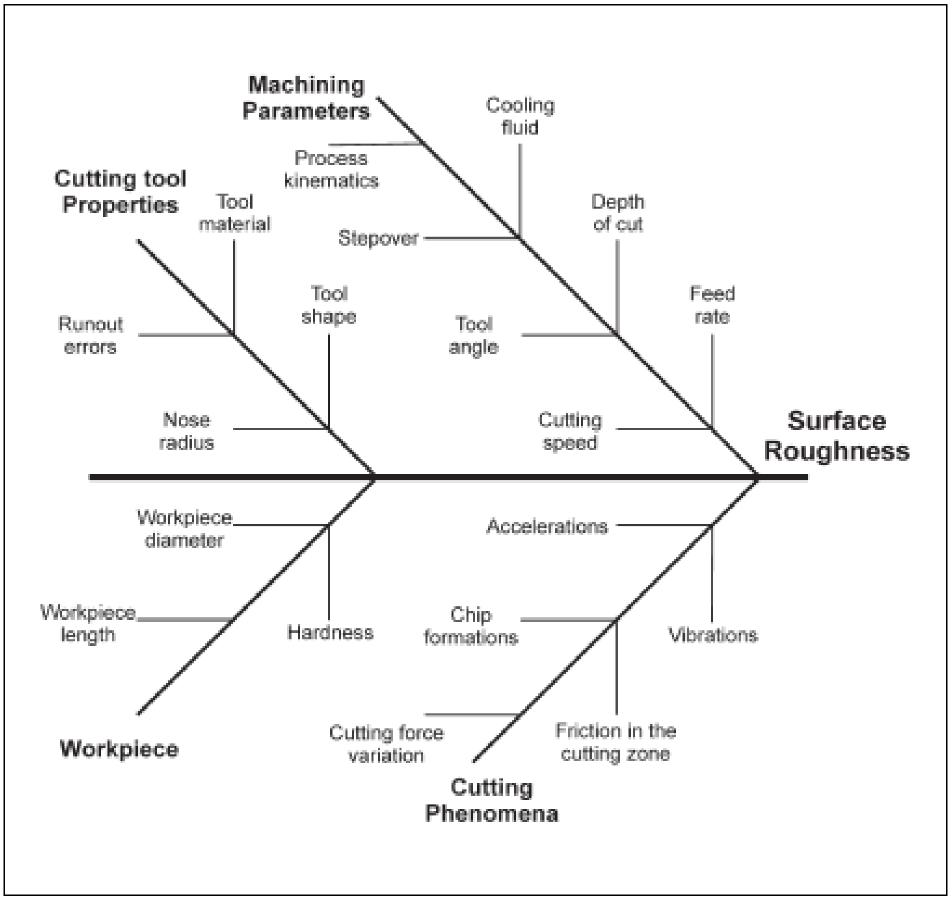

Figure 1.1 Fishbone diagram with factors that influence on surface roughness

1.2 Background and Rationale

The quality of machined components is evaluated by how closely they adhere to set product specifications of length, width, diameter, surface finish, and reflective properties. High speed turning operations, dimensional accuracy, tool wear, and quality of surface finish are three factors that manufacturers must be able to control [1]. Among various process conditions, surface finish is central to determining the quality of a workpiece.

Surface roughness is harder to attain and track than physical dimensions are, because relatively many factors affect surface roughness. Some of these factors can be controlled and some cannot. Controllable process parameters include feed, cutting speed, tool geometry, and tool setup. Other factors, such as tool, workpiece and machine vibration, tool wear and degradation and workpiece and tool material variability cannot be controlled as easily [2]. There are usually based on experience and trial and error to obtain suitable cutting data for each cutting operation involved in machining a product.

A reference chart was then developed to ease during setups. This chart, like the commonly used feed rate, spindle speed, and depth of cut charts, would serve as a reference to operators who routinely perform lathe setups to eliminate uncertainty in the setup procedure, minimize required setup time, maximize setup and operational efficiency, and reduce overall operating costs. While there are many machining optimization parameters that have been developed and put into tables, an area that has been overlooked is that of correlation between the cutting tool length and the resultant surface roughness. Thus, the choice of optimized cutting parameters becomes very important to control the required surface quality.

The aim of this research is to investigate the effects of varying cutting tool length on the resulting surface roughness in the dry turning operation of aluminum alloy 6061. To achieve such objective, the research should have completed an experimental design that allows considering different level interactions between the cutting parameters (cutting speed, feed rate, depth of cut and tool length) on the dependant variable, surface roughness.

1.2.1 Research Objective

The objective of this study is to evaluate the effect of different cutting tool length on turning performance. A mathematical model for predicting the surface roughness will be developed. Finally the optimum cutting condition will also be proposed. After performing a cutting process, each cutting point (insert) and chip formation are check to see the appearance and condition on the surface cutting point and chip formation for each cutting condition setup by using optical microscope. The data will be compared and analyze (in term of type tool wear and chip form) for each cutting condition setup.

1.3 Research Problem

1.3.1 Statement of Research Problem

How the cutting tool length will affects the surface roughness of machined workpiece produced in turning operation.

1.3.2 Research Questions

1. What is ideal length for cutting tool to produce a good surface finish?
2. How the length of cutting tool affects the surface finish of workpiece?

1.4 Dependent and Independent Variable

The experiment was conducted using work piece material namely Aluminum Alloy 6061. This particular material, while not representative of all workpiece materials, was chosen specifically because of its widespread use in industry, and because it would be beyond the scope of this research to involve all materials at this level. The material was a standard 60 mm diameter machined bar. The bar stock consisted of several individual pieces, each being 90 mm length. The additional 25 mm in length allowed for chucking of the bar stock. The different bar lengths, were tested by machining at different tool length and then measured for surface roughness. Dry turning process is use. The independent variables for the procedures are cutting speed, feed rate, depth of cut, and tool length. The tool length variable is introduced because to investigate that the vibration generated by varying the tool length could affect the resulting surface finish. The dependent variable for the procedure is surface roughness.

1.5 Scope of Study

The scopes of thesis study are as follows:

1. Performance will be evaluated primarily in terms of surface roughness and chip form together with initial tool wear will also briefly discuss.
2. A aluminium alloy 6061 will be used as the workpiece material
3. A 20 X 20 cutting tool holder with carbide insert will be used as cutting material
4. Cutting speed, feed rate, depth of cut and tool length will be used as cutting parameters.
5. Design of Experiments techniques will be used.

1.6 Organization of Project Report

This project report is made up of five main chapters namely Introduction for Chapter 1, Literature Review for Chapter 2, Methodology for Chapter 3, Result and Discussion for Chapter 4, and lastly Conclusion for Chapter 5. First chapter describes an overview of the study and objectives that influences the study. Chapter 2 is organized to summarize the literature reviews of the relevant topic and previous work in this field to give a clear picture and guidance towards achieving the objective. In Chapter 3 describe the design or procedural plan to be followed and method to be used to conduct the study. All experiment data and result are presented in Chapter 4. In this chapter, discussions on the results are obtained and comparison will be made from previous research and theory. Finally the conclusion of study and recommendation for future work will be describes on Chapter 5.