UNIVERSITI TEKNIKAL MALAYSIA MELAKA

AN EXPERIMENTAL STUDY OF THE EFFECT OF THE RPM TO SURFACE ROUGHNESS IN MILLING

This report submitted in accordance with requirements of the University Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree Manufacturing Engineering (Manufacturing Process) Honours.

By

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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TAJUK: ***“ An experimental study of the effect of RPM to surfaces roughness in milling’’***

Sukacita dimaklumkan bahawa tesis yang tersebut di atas bertajuk ***“ An experimental study of the effect of RPM to surfaces roughness in milling ”*** mohon dikelaskan sebagai terhad untuk tempoh lima (5) tahun dari tarikh surat ini memandangkan ia mempunyai nilai dan potensi untuk dikomersialkan di masa hadapan.

Sekian dimaklumkan. Terima kasih.

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DECLARATION

I hereby, declared this report entitled "An experimental study of the effect of RPM to surfaces roughness in milling" is the results of my own research except as cited in references.

Signature : ………………………………………….

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process) with Honours. The members of the supervisory committee are as follow:

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ABSTRACT

Surface roughness is one of the most common performance measures in machining and an effective parameter in representing the quality of machined surface. Surface roughness is influenced by controlled machining parameters such as feed rate, cutting speed and depth of cut. The surfaces profile and roughness of a machined workpiece are two most important product quality characteristics and most cases a technical requirement for mechanical product.. In this study, an experimental is carried out to study presented the effect milling cutting speed to surfaces roughness on mild steel and aluminum. For this experiment, design of experiment (DOE) approach was used in finding the effect of cutting speed on the surfaces roughness. The surface roughness of work piece have been analyzes by using a Profilometer Surface Roughness tester Mitutoyo SJ-301. The data will analyze using Minitab 14 software. The result shows the optimum factor.

ABSTRAK

Kekasaran permukaan adalah salah satu langkah pengukuran prestasi paling biasa dalam pemesinan dan satu parameter yang efektif dalam mewakili kualiti permukaan bendakerja yag telah dimesin permukaannya. . Kekasaran permukaan dipengaruhi parameter pemesinan seperti kadar suapan, kelajuan dan kedalaman pemotongan oleh mata alat. Permukaan-permukaan berprofail dan kekasaran sesuatu bendakerja pemesinanan adalah dua hasil penting menentukan ciri-ciri kualiti dan satu keperluan teknikal untuk produk mekanikal. Dalam kajian ini, satu eksperimen dijalankan untuk mengkaji untuk membentangkan kesan kelajuan pemotongan mesin “milling” untuk permukaan-permukaan kekasaran pada bendakerja seperti keluli sederhana dan aluminum. Untuk eksperimen ini, pendekatan rekabentuk ujikaji (D.O.E) digunakan dalam mencari kesan kelajuan memotong di permukaan-permukaan kekasaran. Kekasaran permukaan bahan kerja diukur dengan menggunakan penguji Profilometer Surface Roughness Mitutoyo SJ-301. Data akan dianalisis menggunakan perisian Minitab versi 14 . Keputusan-keputusannya akan menunjukkan faktor yang optimun..

DEDICATION

For my beloved dad, mom, and my brother and my sister.
Especially for my special one.
Special thanks for my supervisor.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

AA	-	Arithmetic average
ANOVA	-	Analysis of Variance
AISI	-	American Iron and Steel Institute
CLA	-	Centre Line Average
DOE	-	Design of Experiment
FPT	-	Feed per tooth
HSM	-	High Speed Machining
Ra	-	Roughness Average
RMS	-	Root Mean Square
RPM	-	Rev per Minute
Rz	-	Arithmetic mean

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CHAPTER 1

INTRODUCTION

1.1 Research background

Metal cutting is one of the most significant manufacturing processes in the area of material removal. J. T. Black (1979) defined metal cutting as the removal of metal chips from a workpiece in order to obtain a finished product with desired attributes of size, shape, and surface roughness.

Milling is the indicated process when needed to make all the other parts that cannot be made on the lathe. The demand of low tolerances and better quality products has forced manufacturing industry to continuously progress in quality control and machining technologies.

S.Lou *et al.* (1999) stated end mill process is most common metal removal operations used in industry. Like face milling, end milling can easily machine a workpiece surface into a flat surface. It can also use appropriate fixtures to machine complicated workpieces such as aircraft engines. One machining method of the end milling operations widely used for mold die and machine parts are side milling. It uses a peripheral cutting edge of an end mill to achieve a relatively broad-range face milling on the vertical wall of a workpiece.

One of the important factors to evaluate the machining quality for the machining process is surface roughness, because it affects the functional characteristics of the workpiece such as compatibility, fatigue resistance and surface friction. For the milling process the major parameters to evaluate the surface roughness include tool geometry, cutting speed, feed rate, tool wear, axial depth of cut, radial depth of cut, and runout as well as overhang length of the end mill.

In today's manufacturing industry, special attention is given to dimensional accuracy and surface finish. Thus, measuring and characterizing the surface finish can be considered as the predictor of the machining performance. A lot of researches have been conducted for determining optimal cutting parameters in machining processes.

Chen Lu (2008) noted the surface profile and roughness of a machined workpiece are two of the most important product quality characteristics and in most cases a technical requirement for mechanical products. Achieving the desired surface quality is of great importance for the functional behavior of a part

Mohammed T. Hayajneh *et al*. (2007) admitted the demand for high quality and fully automated production focuses attention on the surface condition of the product, especially the roughness of the machined surface, because of its effect on product appearance, function, and reliability. For these reasons it is important to maintain consistent tolerances and surface finish. Tabenkin (1985) write quality of the machined surface is useful in diagnosing the stability of the machining process, where a deteriorating surface finish may indicate workpiece material non-homogeneity, progressive tool wear and cutting tool chatter.

G. Boothroyd and W. Knight (1989) stated that several factors influence the final surface roughness in end milling operation. Factors such as spindle speed, feed rate, and depth of cut that control the cutting operation setup is done in advance. However, Kutner *et al.* (1990) stated that factors such as tool geometry, tool wear, and chip formation, or the material properties of both tool and workpiece are uncontrolled.

The goal of the research is to determine the possible effect of milling spindle speed on the aluminum surface and mild steel by conducting the surface roughness test of the workpieces that produce. This included using special machine to check for the surface roughness produce by different speed of cutting. The results from this research will assist to replace the traditional “trial and error” method by D.O.E method which may lead to the improvements in manufacturing of aircraft and manufacturing industry. Aluminum AISI6061 is chosen as the material to test because it is widely used for construction of aircraft structures, such as wings and fuselages, more commonly in automation precision parts. Mild steel AISI1030 also are chosen because it is widely used in studies lab activities.

1.2 Problem Statement

For the industry nowadays, mostly the machine operator usually using “trial and error” method to approach set up for high speed milling and this method is not effective and also very time consuming process. Commonly, machinists have to set the different speed according to their experience with just eye inspection on the surface roughness and this could not get the perfect surface finish. Besides, this method is not effective because they using several type of spindle speed, hence it is difficult to control the tolerance causing low quality of the products. Besides, the wrong setting of parameters such as depth of cut without guideline will wasting the cutting tool life hence producing poor surface finish while damaging to the cutter and machine. The industrial also facing challenges to improve the quality of products and process with minimum cost and time constrains because this involve manpower and details research to solve the problem that faced.

1.3 Scope of study

This study was focusing to analyze the cutting speed effect to the surface roughness of workpieces. The factors that involved are spindle speed, depth of cut and also feed rate Cutting tool involved is the faced mill. Type of material used was mild steel AISI 1030, alluminium AISI6061. In order to obtain desired surface roughness, cutting parameters values should be determined before the machining processes put in action. Some of those data could be taken from machinist handbooks or by conducting experiments Design of Experiment (D.O.E) has been used in order to study the relationship between these variables on surface roughness. Surfaces roughness is measured by Profilometer Surface Roughness tester Mitutoyo SJ-301.

1.4 Objective of the study

The aim of this proposed study is to develop a better understanding of effect cutting speed on the surface roughness in milling process. In order to achieve this aim, the following objectives have been considered:

- To analyze the effect of spindle speed to the surface roughness of alluminium and mild steel.
- Decrease the lead time and mass production in industry by inventing an optimum cutting speed besides improve the quality of surface finish.
- To determine the optimum spindle speed of surface roughness.

1.5 Importance of Study

The invention of better surface finish using milling by controlling the parameters could help the automotive and aircraft industry to produce better quality parts and increase the challenges in the global markets. Besides, the D.O.E method could help the industry to save time and cost compare to the previous "trial and error" method which need experienced machinist to test the surface finish using different of parameters speed.

1.6 Expected Result

The surface roughness produce from high speed milling can be improved by controlling the main parameters such as depth of cut, spindle speed and also feed rate. Different spindle speed, feed rate and depth of cut will produce different type of surface roughness. Besides, by apply D.O.E method on this experiment, the optimum of parameters speed will be obtain to produce the best surface finish.

1.7 Gantt Chart for PSM 1

Table 1.0: Gantt chart for PSM 1

No	Task	Status	Week												
			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th
1	Select of PSM title and discussion with supervisor.	Propose													
		Actual													
2	Search of information and preparation of daft for chapter 1	Propose													
		Actual													
3	Submission of chapter 1	Propose													
		Actual													
4	Preparation of chapter 2 and getting more journal of research.	Propose													
		Actual													
5	Submission of draft of chapter 2.	Propose													
		Actual													
6	Submission of chapter 2 and finding the raw material for the experiment.	Propose													
		Actual													
7	Submission of draft chapter 3.	Propose													
		Actual													
8	Submission of chapter 3.	Propose													
		Actual													
9	Preparation of draft of full technical report.	Propose													
		Actual													
10	Submission of the draft of full report and preparation for oral presentation	Propose													
		Actual													
11	Oral presentation.	Propose													
		Actual													
12	Submission of technical report.	Propose													
		Actual													

1.8 Gant chart for PSM 2

Table 1.1: Gantt chart for PSM 2

No	Task	Status	Week																	
			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th
1	Improvement of PSM 1	Propose																		
		Actual																		
2	Discussion with supervisor	Propose																		
		Actual																		
3	Material preparation	Propose																		
		Actual																		
4	Specimen Machining	Propose																		
		Actual																		
5	Data Collecting-Roughness measurement	Propose																		
		Actual																		
6	Analysis using Minitab	Propose																		
		Actual																		
7	Preparation of chapter 4	Propose																		
		Actual																		
8	Preparation of chapter 5	Propose																		
		Actual																		
9	Submission Draft report	Propose																		
		Actual																		
10	Slide presentation preparation	Actual																		
		Propose																		
11	PSM presentation	Actual																		
		Propose																		
12	Final editing report and hard cover making	Actual																		
		Propose																		
13	Submission PSM report	Actual																		
		Propose																		