



**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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2009



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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SESI PENGAJIAN: 2008/2009 Semester 2

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
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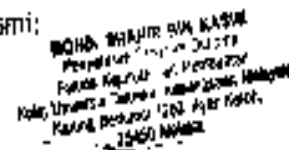
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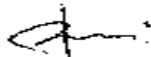
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## DECLARATION

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.




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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 yang telah dimesin permukaannya. . Kekasaran permukaan dipengaruhi parameter pemesinan seperti kadar suapan, kelajuan dan kedalaman pemotongan oleh mata alat. Permukaan-permukaan berprofil dan kekasaran sesuatu bendakerja pemesinan 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 aluminium. 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 optimum..

## DEDICATION

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



## ACKNOWLEDGEMENTS

Alhamdulillah, finally I have finished my Final Year Project for the fulfillment of Bachelor of Manufacturing Engineering (Process). First and foremost, I would like to dedicate my deepest gratitude to University Teknikal Malaysia Melaka, especially for Manufacturing Faculty for the provision of funding to carry out this research and my bachelor degree study.

A special thanks to my supervisor, Encik Mohd Shahir Kasim for the supervision along the time I was doing this project. I greatly appreciate his consistent encouragement, advice and invaluable guidance throughout the course of this project.

I also like to express my thanks to all technician staff at FKP Laboratory that helping me in conducting my experiment especially to Encik Mohd Taufik, a technician at Machinshop. Lab in guidance me in handling surface grinding machine, Encik Jaafar Lajis also thanks, for helping me in material order and guidance me in using facilities in metrology Lab for the experimental analysis process.

Finally, I would like to express my deepest appreciation and gratitude to my family members for their love, sacrifice, motivation and support given during the course of this project. Last but not least, I would like to thank those who have contributed directly or indirectly toward the success of this project.

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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



## LIST OF APPENDICES

- A - Surface Roughness Data Sheet
- B - D.O.E Session Report
- C - SEKN Insert Style Specification

# 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,

aluminium 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 aluminium 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															
			1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	6 <sup>th</sup>	7 <sup>th</sup>	8 <sup>th</sup>	9 <sup>th</sup>	10 <sup>th</sup>	11 <sup>th</sup>	12 <sup>th</sup>	13 <sup>th</sup>			
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 Gantt chart for PSM 2

Table 1.1: Gantt chart for PSM 2

No	Task	Status	Week	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	6 <sup>th</sup>	7 <sup>th</sup>	8 <sup>th</sup>	9 <sup>th</sup>	10 <sup>th</sup>	11 <sup>th</sup>	12 <sup>th</sup>	13 <sup>th</sup>	14 <sup>th</sup>	15 <sup>th</sup>	16 <sup>th</sup>	17 <sup>th</sup>	18 <sup>th</sup>	
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																				