UNIVERSITI TEKNIKAL MALAYSIA MELAKA

A STUDY OF EFFECTS OF MACHINING PARAMETERS ON SURFACE ROUGHNESS IN END MILLING

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

by

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

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SESI PENGAJIAN : 2009/2010 Semester 2

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DECLARATION

I hereby, declared this report entitled "Study of Effects of Machining Parameters on Surface Roughness in End Milling" is the results of my own research except as cited in references.

Signature	:	……..
Author's Name	:	NOR KAMARIAH BINTI MOHAMAD KHALID
Date	:	17th MAY, 2010

APPROVAL

This PSM submitted to the senate of UTeM and has been as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process). The member of the supervisory committee is as follow:

……

Dr. Mohd Rizal Bin Salleh

Main Supervisor

ABSTRACT

Milling is one of the fundamental forms of machining operation among several industrial machining processes. End milling, one of the milling operation is the most common metal removal operation and widely used in a variety of manufacturing industries including the aerospace and automotive sectors. Both sectors are stressed most on the quality of the surface finish. Thus, the main objective of this study is to develop a better understanding of the effects of machining parameters on the surface roughness in end milling. Machining parameters involved in this study are cutting speed, feed rates and depth of cut. The material used to test the surface roughness is mild steel 1020. Machining test was performed under dry cutting condition. Full factorial of experiment design was applied in order to determine the test run for the experiment and it also used to analyze the data obtained. The result showed feed rate gave most significant effect on the surface roughness. The optimum values of parameters could be set up at high level cutting speed, low level feed rate and low level depth of cut to produce a good surface finish.

ABSTRAK

Proses kisar adalah salah satu daripada asas operasi pemesinan yang terdapat dalam industri pemesinan. “End milling” merupakan salah satu daripada operasi kisar yang umum dalam operasi pembuangan metal. Proses ini digunakan secara meluas dalam pelbagai industri pembuatan termasuklah sektor ruang angkasa dan automotif. Kedua-dua sektor ini sangat menekankan terhadap kualiti permukaan yang terhasil. Oleh itu, objektive utama kajian ini adalah meningkatkan pemahaman terhadap kesan-kesan pembolehubah pemesinan ke atas kekasaran permukaan dalam “end milling.” Pembolehubah yang terlibat dalam kajian ini adalah kelajuan pemotongan, kadar suapan dan kedalaman pemotongan. Bahan yang digunakan untuk menguji kekasaran permukaannya adalah keluli sederhana 1020. Ujian pemesinan telah dijalankan dalam keadaan pemotongan yang kering. Kaedah “full factorial” digunakan untuk menentukan bilangan ujikaji perlu yang di jalankan dan digunakan untuk menganalisis data yang diperolehi. Keputusan yang diperoleh menunjukkan kadar suapan memberi kesan yang paling penting terhadap kekasaran permukaan. Nilai-nilai optimum pembolehubah boleh ditetapkan pada kelajuan pemotongan tinggi, kadar suapan rendah dan kedalaman pemotongan rendah bagi mendapatkan permukaan akhir yang baik.

DEDICATION

This study is dedicated to my beloved parents, Mohamad Khalid Bin Abdullah and Kamsiah Binti Jalil.

To my supervisor, lecturers and fellow friends for all their helps and supports.

ACKNOWLEDGEMENT

First and foremost, I would like to express my gratitude and gratefulness to Allah Almighty for His guidance and blessing me with the strength to complete this Projek Sarjana Muda. I also would like to give my special thank to my supervisor, Dr. Mohd Rizal Bin Salleh for his guidance, advices and support all the way through the execution of this project. My appreciation also goes to all the technicians (FKM Laboratory, Metrology Laboratory, and Machine Shop) for their assistance, contribution and cooperation during my experiment stage. Last but not least, I also would like to give my special thank and appreciation to my both my beloved parents, Mohamad Khalid Bin Abdullah and Kamsiah Binti Jalil, all my colleagues and friends especially Mohd Esam that helped and supported me a lot in this degree project either directly or indirectly.

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LIST OF ABBREVI ATIONS

AA	-	Arithmetic Average
BUE	-	Built-up Edge
CLA	-	Centre Line Average
CNC	-	Computer Numerical Control
Co	-	Cobalt
Cr	-	Chromium
CS	-	Cutting Speed
DOC	-	Depth of Cut
DOE	-	Design of Experiment
FR	-	Feed Rate
HSS	-	High Speed Steel
IPM	-	Inches per Minute
Mo	-	Molybdenum
Ra	-	Roughness Average
RMS	-	Root Mean Square
SFM	-	Surface Feet per Minute
V	-	Vanadium
W	-	Tungsten

CHAPTER 1
INTRODUCTION

1.1 Background Of The Study

Milling is a material removal process which can create a variety of features on a part by cutting away the unwanted material. The milling process is one of the fundamental forms of machining among several industrial machining processes. End-milling is the most common metal removal operation encountered. It is widely used in various fields of manufacturing industries including the aerospace and automotive sectors, where quality is an important factor in the production of slots and dies in both sectors.

Based on Yang and Chen (2001), surface roughness is the crucial indicator for the quality of a machined surface. This can be seen where the quality of the surface plays a very important role in the performance of milling. A good-quality milled surface significantly improves fatigue strength, corrosion resistance, and creep life. Surface roughness also affect several functional attributes of parts, such as wear, heat transmission, ability of holding a lubricant, coating, or resisting fatigue. Thus, the desired finish surface is usually specified and the appropriate processes are selected to reach the required quality. There is several factors influence the final surface roughness in end milling operation. Factors such as cutting speed, feed rate, and depth of cut that control the cutting operation can be setup in advance (Lou et. al., 1998).

However, factors such as tool geometry, tool wear, and chip formation, or the material properties of both tool and workpiece are uncontrolled (Hyunh & Fan, 1992).

Generally, one could use or refer the hands on data tables that are provided in machining data handbooks as a starting point to determine the cutting parameters. Other conventional method that can be used to determine the optimal machining condition is by using trial and error approach. However, it is very time consuming process to identify the optimum cutting condition for a particular operation. Nowadays, a Design of Experiment (DOE) has been used to select manufacturing process parameters that could result in a better quality product (Yang & Chen, 2001). The DOE is an effective approach to optimize the throughput in various manufacturing-related processes (Fidan et al., 1998).

This study is mainly about an experimental test to begin the characterization of surface quality of mild steel for the end-milling process. The study will discover the effects of machining parameters on the surface roughness of the mild steel using three different factors in the end-milling process. The three different parameters will result vary surface roughness. Hence, from the result obtain the optimum parameters can be identified. In order to analyze the data obtained, the DOE approach will be used.

1.2 Problem Statement

Continuously improve quality control of metal cutting processes in metal cutting industry is a result from the higher demand of consumer needs for quality metal cutting related products (more precise tolerance and better product surface roughness). Within the metal cutting processes, the end-milling is one of them. The surface roughness which plays a very important role in functionality of produced part is one of the major quality attributes of an end-milled product. The proper setting of cutting parameters is crucial before the process takes place in order to obtain a better surface roughness. Three cutting

parameters which are cutting speed, feed rate, and depth of cut have been choosing with the aim to study and understand the effect on the surface roughness.

1.3 Objective

The purposes of this study are:

- To invetsigate the effect of the machining parameters on the surface roughness in the end milling process on mild steel
- To identify the optimum value of the machining parameters involved in producing a good surface finish

1.4 Scope Of Project

This project is mainly aim on determining the appropriate parameters in order to obtain a good surface quality in the end-milling process. In this study, it focuses on the effect of the cutting parameters (cutting speed, feed rate, and depth of cut) on the surface roughness. The material used in this study is mild steel. The machining operation was conducted using the CNC milling machine. The method of milling used is climb milling. Surface roughness that obtained from the machining will be tested using Surface Roughness Measurement with stylus. Next, the data gained will be analyzed using MiniTab software.

1.5 Organization Of The Report

Generally, this report is divided into two parts which are Projek Sarjana Muda (PSM) I and PSM II. Overall this report contains of six main chapters. The five main chapters are divided into two parts which the first part contains three chapters that consists of introduction, literature review and methodology whereas the second part followed by the two more chapters; results and discussion and finally, conclusion and recommendation of the study.

Table 1.1: Organization of the Report

Chapter	Content
Chapter 1 (Introduction)	- Overview of the study - Problem statement - Objective of the study - Scope of project - Organization of the report
Chapter 2 (Literature Review)	- Literature review containing the theory involve that taken from taken from journal, books, and articles
Chapter 3 (Methodology)	- All method that have been used to achieved the objective and obtain the result - Process Flow Diagram
Chapter 4 (Result and Analysis)	- Show the result obtain from the experiment conducted - Analysis of the data obtain using Design of Experiment
Chapter 5 (Discussion)	- Discussion on the result obtain
Chapter 6 (Conclusion and Recommendation)	- Conclusion on the finding - Suggestion/recommendation of the study for improvement

1.6 Gantt Chart

Table 1.2: PSM 1 Gantt Chart

No	Yeat	2009																					
	Activity	July				Aug				Sept				Oct				Nov					
1	PSM title confirmation																						
2	Problem statement identification																						
3	objective and scope of study																						
4	Finding literature review																						
5	PSM 1 report writing																						
6	PSM 1 report review																						
7	PSM 1 report submission																						
8	Preparation for PSM 1 presentation																						
9	PSM 1 presentation																						
	Planning																						
	Actual																						

Table 1.3: PSM 2 Gantt Chart

No	Year	2010																					
	Activity	Jan				Feb				Mar				Apr				May					
1	Improvement on PSM 1																						
2	Finding literature review																						
3	Machining and material preparation																						
4	Machining process																						
5	Surface roughness measurement																						
6	Data Analysis using MiniTab																						
7	PSM 2 report writing																						
8	PSM 2 review																						
9	PSM 2 submission																						
10	Preparation for PSM 2 presentation																						
	PSM 1 presentation																						
	Planning																						
	Actual																						

CHAPTER 2

LITERATURE REVIEW

The literature review is conducted in order to achieve the objectives of this research. It contains of the information of the end milling operation, machining parameters used, surface roughness and some overview of material used. All of this information is served as the guidelines for this study. It also used to support the result of the study.

2.1 Introduction

Machining or simply metal cutting process can be defined as a process designed to change the size, shape, and surface of a material through removal of materials that could be achieved by straining the material to fracture or by thermal evaporation. It is one of the oldest processes for shaping components in the manufacturing industry. There is various kind of machining operation such as milling, turning, drilling, grinding and sawing. Each of them is capable to generate a certain part geometry and surface texture.

Milling is the removal of metal by feeding the workpiece past a rotating multipoint cutter. It is used to produce a variety of surfaces by using a circular –type cutter with multiple teeth or cutting edges which successively produce chips as the cutter rotates. The shape of the milling cutter and the path that it takes determine the shape of the surface produced.

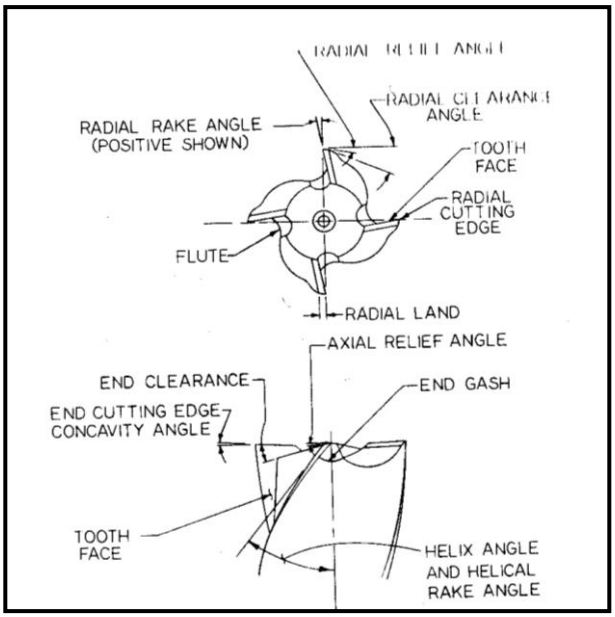

Figure 2.1: Element of End Milling (Moltrecht, 1981)

2.1.1 End Milling

End milling is an important and common machining operation because of its versatility and capability to produce various profiles and curved surface. The cutter, called end mills are used to mill plane surfaces, slots, profile, and three-dimensional (3D) contours. End mills are characterized by having cutting edges on end face as well as on the periphery. Most standard end milling cutters are made of two or four flutes in sizes up to approximately 1 inch. They also can be found in larger size. In increasing the numbers of the flutes on the end mill will helps to stabilize the cutter when milling slot and thus, allows a faster feed to be used.

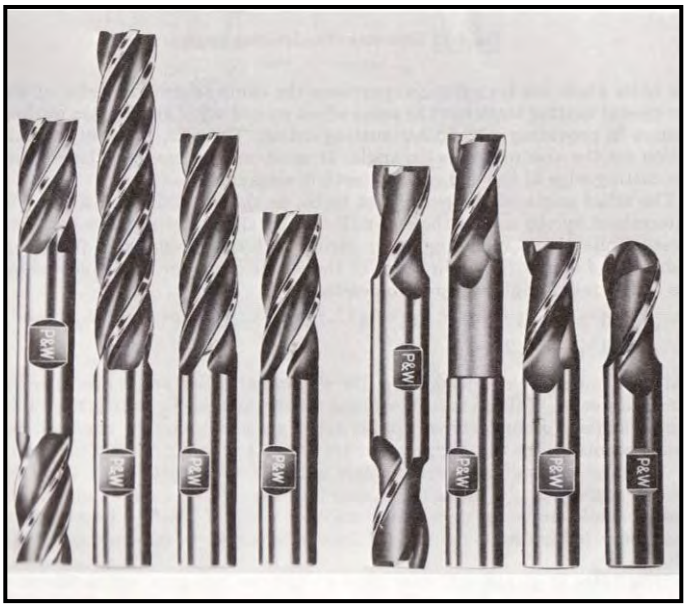

Figure 2.2: A Group of Different End Milling Cutters (Moltrecht, 1981)

2.1.2 Methods of Milling

Basically, there are two methods in which a milling cutter can be fed into the workpiece. The two methods of milling can be known as down milling and up milling methods. Both methods can be applied in machining depend on the material of the workpiece.

2.1.2.1 Down Milling

Down milling is also referred as climb milling. In down milling, the direction of the cutter rotation is same as the feeding movement of the workpiece. For example, if the cutter rotates clockwise, the workpiece is fed up to the left. The chips are cut to maximum thickness at initial engagement of cutter teeth with the workpiece, and decrease to zero at the end of its engagement.

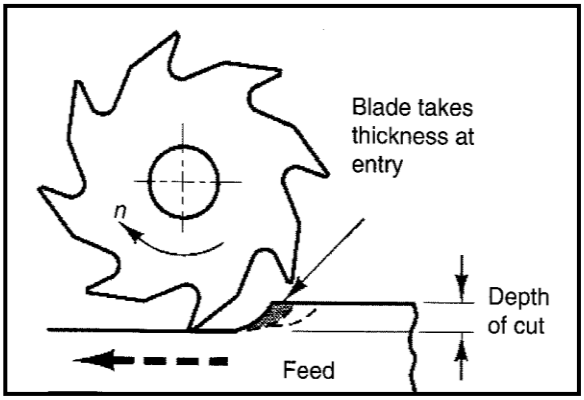

Figure 2.3: Down Milling (Youssef & El-Hofy, 2008)

The cutting forces in down milling are directed downward. The workpiece is pushed down and into the cutter. Hence, less clamping and machining power are required. The extra force places more stress on the machine slides and ball screws. Thus, this method of milling should not be attempted if machines do not have enough rigidity and are not provided with backlash eliminators. Under such circumstances, the cutter climbs up on the workpiece and the arbor and the spindle may be damage.

Advantages of down milling include the following:

- Fixtures are simpler and less costly, as cutting forces acting on downward
- Flat workpieces or plates that cannot be firmly heldcan be machined by down milling
- Cutter with higher rake angles can be used, which decrease the power requirements
- Tool blunting is less likely
- Down milling is characterized by fewer tendencies of chattering and vibration, which leads to improves surface finish