UNIVERSITI TEKNIKAL MALAYSIA MELAKA

SURFACE FINISH STUDY OF MILD STEEL MACHINED BY CARBIDE CUTTING TOOLS

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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I hereby declare that this report entitled **"SURFACE FINISH STUDY OF MILD STEEL MACHINED BY CARBIDE CUTTING TOOLS"** 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 honour. The members of the supervisory committee are as follow:

……………………………………………….

<u>MR. SHUKOR BIN SALLEH</u>

(PSM Supervisor)

ABSTRACT

The main goal of this project is to analyze the effects of the parameters on surface roughness in turning process. Generally there are three parameters that will affect the surface roughness which are cutting speed, feed rate and depth of cut. Roughness is a measure of the texture on a surface. It is quantified by the vertical deviations of a real surface from its ideal form. If these deviations are large, the surface is rough and if it is small the surface is smooth. Surface roughness constitutes one of the most critical constraints for the selection of machine tools and cutting parameters in metal cutting operations. In this study, the Taguchi's method was used to study the effects of cutting parameters which are cutting speed, feed rate and depth of cut. The material used in this research was mild steel AISI 1020. Machining trials was conducted at different cutting conditions using carbide cutting tools. Surface roughness values were measured using surface roughness tester. It was shown that feed rate was given the highest influence of the surface roughness. The study is importance to machinist in the selection of appropriate combinations of machining parameters for high-speed turning of mild steel AISI 1020 workpiece using carbide cutting tool. The experimental results reveal that the most significant machining parameter for surface roughness is feed rate followed by depth of cut and cutting speed.

ABSTRAK

Matlamat utama projek ini adalah untuk menganalisis kesan parameter terhadap kekasaran permukaan produk semasa proses melarik. Umumnya terdapat tiga parameter yang member kesan kepada kekasaran permukaan dimana ianya adalah halaju pemotongan, kadar suapan dan kedalaman pemotongan. Kekasaran ialah pengukuran tekstur sesuatu permukaan. Kekasaran permukaan merupakan salah satu perkara yang paling penting untuk pemilihan peralatan mesin dan parameter permotongan dalam operasi pemotongan logam. Di dalam kajian ini, 'Taguchi method' akan digunakan untuk mengkaji kesan parameter pemotongan dimana ianya adalah halaju pemotongan, kadar suapan dan kedalaman pemotongan ke atas kekasaran permukaan benda kerja yang akan dimesin di mana ianya adalah 'mild steel AISI 1020'. Pemesinan yang akan dijalankan mengikut parameter pemotongan yang berbeza menggunakan alat pemotong karbida. Nilai kekasaran permukaan akan diukur menggunakan penguji kekasaran permukaan. Hasil daripada kajian ini menunjukkan kadar suapan memberikan kesan yang paling tinggi terhadap kekasaran permukaan benda kerja. Kajian ini penting kepada operator pemesinan untuk memilih kombinasi parameter mesin yang sesuai di dalam pemesinan kelajuan tinggi terhadap benda kerja iaitu 'mild steel AISI 1020' menggunakan alat pemotong karbida. Hasil daripada kajian ini menunjukkan bahawa kadar suapan memberikan kesan yang paling besar diikuti oleh kedalaman pemotongan dan halaju pemotongan.

DEDICATION

To my dearest parents, Mohamad Bin Md. Saman and Zaliha Binti Ismail
for their love, care and supports.

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In the Name of ALLAH The Most Gracious, Most Merciful

First of all, thanks to ALLAH S.W.T for giving me the strength and patience in order to accomplish the research of my final year project.

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LIST OF ABBREVIATIONS, SIGNS, AND SYMBOLS

AISI	-	American Iron and Steel Institute
C	-	Carbon
Cu	-	Cooper
FKP	-	Fakulti Kejuruteraan Pembuatan
Mn	-	Manganese
P	-	Phosphorus
PSM	-	Projek Sarjana Muda
Ra	-	arithmetic mean value (roughness average)
Rpm	-	revolution per minute
Rq	-	root mean square average
S	-	Sulfur
UTeM	-	Universiti Teknikal Malaysia Melaka
USA	-	United State of America
ATC	-	Automatic tool changer
CNC	-	Computer Numerical Control
AA	-	Arithmetic average
CLA	-	Center line average
ANOVA	-	Analysis of Variances

CHAPTER 1

INTRODUCTION

1.1 Background of Project

Surface roughness and tolerances are among the most critical quality measures in many mechanical products. As competition grows closer, customers have increasingly focused on quality, making surface roughness become one of the most competitive dimensions in today's manufacturing industries. Surface of a mechanical product can be created with a numbers of manufacturing processes.

Surface roughness is an important measure of the technological quality of a product and a factor that greatly influence manufacturing costs. The mechanism behind the formation of surface roughness is very dynamic, complicated and process dependent and it is very difficult to calculate its value through theoretical analysis.

Mild steel is used in this project which sometimes it referred to as 'carbon steel' or 'plain carbon steel'. Carbon steel makes up the largest part of steel production and is used in a vast range of applications. As others material, it also have its own advantages which are cheap, high stiffness, strong, magnetic and most of it are easy machine and weld. However, this material also has its own disadvantage which is poor corrosion resistance.

This research applies Taguchi's method approach to studying the impact of turning parameters on the roughness of turned surfaces. Taguchi's method approach is quality control methodology that combines control charts and process control with product and process design to achieve a robust total design. It aims to reduce product variability with a system for developing specifications and designing them into a product or process. Named after its inventor, the Japanese engineer-statistician Dr. Genichi Taguchi who also developed the quality loss function.

Taguchi Method is a process or product optimization method that is based on 8-steps of planning, conducting and evaluating results of matrix experiments to determine the best levels of control factors. The primary goal is to keep the variance in the output very low even in the presence of noise inputs. Thus, the processes or products are made robust against all variations.

A metal lathe or metalworking lathe is a large class of lathes designed for precisely machining relatively hard materials. They were originally designed to machine metals; however, with the advent of plastics and other materials, and with their inherent versatility, they are used in a wide range of applications, and a broad range of materials. In machining jargon, where the larger context is already understood, they are usually simply called lathes, or else referred to by more-specific subtype names such as toolroom lathe, turret lathe and etc. These rigid machine tools remove material from a rotating workpiece via the movements of various cutting tools, such as tool bits and drill bits.

Turning is one of the most commonly used processes where metal is removed by rotating the wokpiece with respect to a tool. The workpiece is held in a chuck that is clamped to the spindle. The tool is held in a tool post that is mounted on a cross slide, which provides radial tool movement. If the workpiece is long, both of the ends are held by the chuck and tailstock. The cross-slide is held on the top of a carriage that has motion along the axis between spindle and tailstock centers. Conventional lathes have single motor that rotates the spindle via gearbox and belts (Figure 1.1).

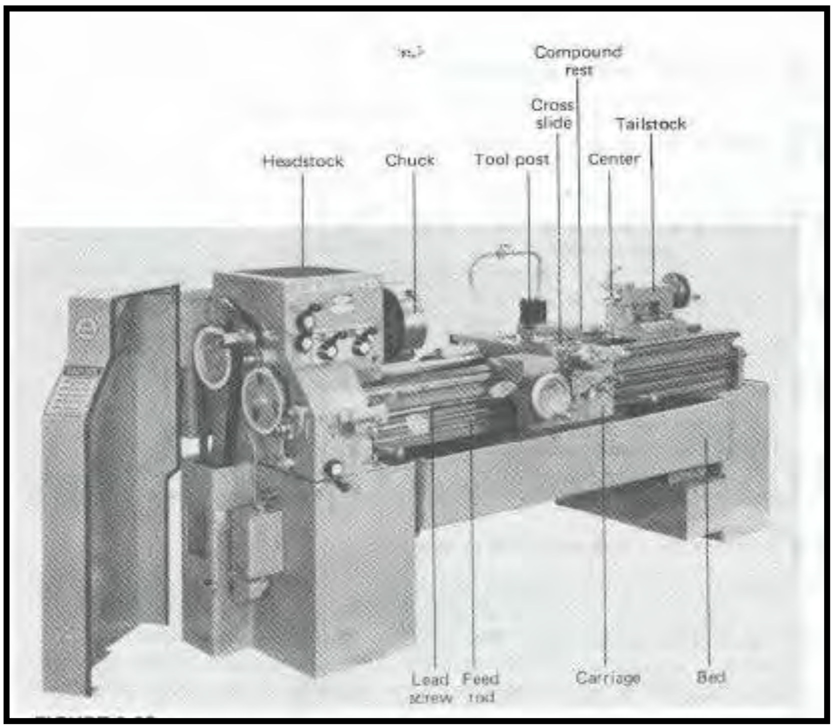

Figure 1.1: Conventional lathe (Bulent, 2002)

CNC is the process of manufacturing machined parts. Numerical Control (NC) is the original name given to this technology and is still often used interchangeably with CNC. NC technology has been one of manufacturing's major developments in the past fifty years. It not only resulted in the development of new manufacturing techniques and the achievement of higher production levels, but it also helped increase product quality and stabilize manufacturing costs (Ismail, 2002).

Due to the increasing demand of precision parts and devices in many industries such as optics, computers, automotive and aerospace etc, it may, in general, be possible to achieve the required precision operations at high accuracy by using expensive manufacturing equipments. In addition to these costly equipments, using a secondary finishing operation such as grinding or polishing may significantly reduce the productivity and introduce set-up errors. There are some ultra precise turning machines, which can produce parts at micro level accuracy. Special machine tool manufacturers produce these machines. But they are very costly compared to standard machine tools used in the industry. These turning machines have to be operated in a temperature controlled, vibration free and stable environment.

In CNC (Computer Numerical Control) turning machines, unlike conventional ones, the feed and spindle speeds are programmed within computer programs (Figure 1.2). In these machines, the turret holds the tools. The turret may contain multiple 6 until 12 cutting tools.

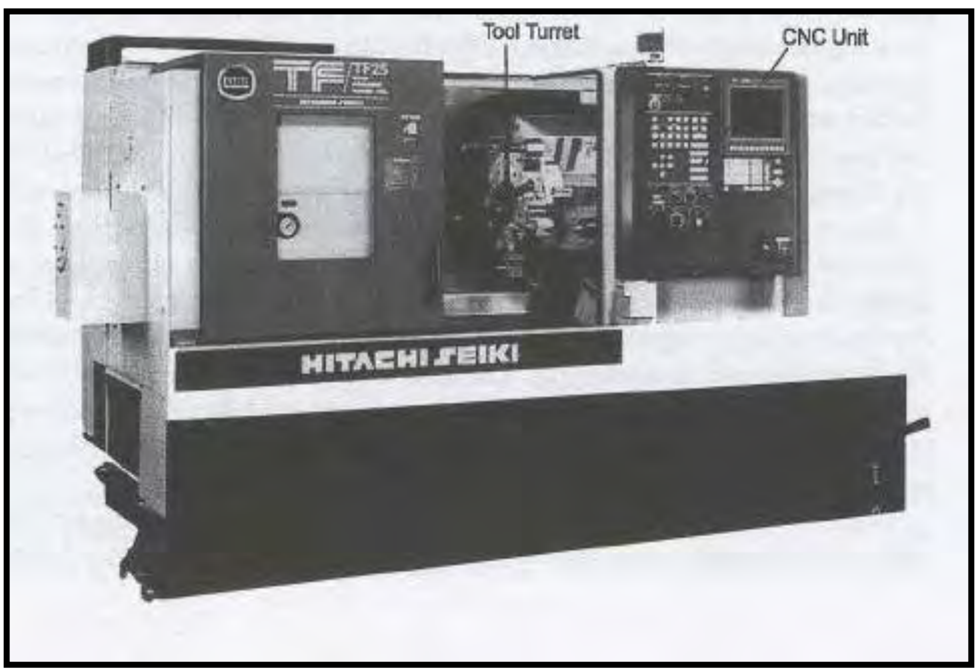

Figure 1.2: CNC turning machine (Bulent, 2002)

CNC lathes are rapidly replacing the older production lathes due to their ease of setting and operation. They are designed to use modern carbide tooling and fully utilize modern processes. The part may be designed and the toolpaths programmed by the CAD/CAM process, and the resulting file uploaded to the machine, and once set and trialled the machine will continue to turn out parts under the occasional supervision of an operator.

The machine is controlled electronically via a computer menu style interface, the program may be modified and displayed at the machine, along with a simulated view of the process. The setter needs a high level of skill to perform the process, however the knowledge base is broader compared to the older production machines where intimate knowledge of each machine was considered essential. These machines are often set and operated by the same person, where the operator will supervise a small number of machines. The design of a CNC lathe has evolved yet again however the basic principles and parts are still recognizable, the turret holds the tools and indexes them as needed. The machines are often totally enclosed, due in large part to Occupational health and safety (OH&S) issues.

Since the introduction of the first NC machine, there have been many applications of NC machining technology such as, turning, grinding, drilling, flame and laser cutting, forming and bending, punching and nibbling, electric discharge machining. In NC there are many sources and look-up tables available for selecting these correct parameters. For turning, the diameter of the workpiece and the surface feet per minute for the material are factors in determining the proper speeds and feed rates (Ismail, 2002).

The important parameters of turning machines are spindle speed, feed rate, depth of cut and tool geometry such as rake face and clearance face**.** Spindle speed is the angular speed of the rotating workpiece. Feed rate is the distance moved by the tool in an axial direction for each revolution of the workpiece. Depth of cut is the thickness of metal removed from the workpiece measured in a radial direction.

The present work concerns with the optimization of the machining parameters in CNC-Turning machine, and study their effects on the surface roughness of mild steel workpiece. The evaluations are defined from the experiments outcomes. All the findings from this study will prove which parameters between cutting speed, feed rate and depth of cut will give most effect to the surface roughness of mild steel using carbide cutting tool especially in CNC turning machine.

1.2 Problem Statement

Currently in CNC turning operation, there are a few conditions of part after machining. The conditions of the part are recognized by referring the accuracy of the dimension and surface roughness. The good surface roughness is caused by many variables. It might be cutting speed, feed rate or depth of cut. Hence, it is important to know suitable feed rate, cutting speed and depth of cut in order to get fine surface roughness. For this project, the main effects of machining parameters that will be analyze are feed rate, cutting speed and depth of cut while machining process towards surface roughness. After machining process, the surface roughness shall gives results depending on several of feed rate, cutting speed and depth of cut used. Type of material used was mild steel and in order to investigate the effect of those variables, an analysis will be carry out with help of the previous study on the literature review on investigations into the effect of cutting parameters on surface roughness in CNC turning machine.

1.3 Objective of Project

The purposes of this project are:

1. To analyze the effects of feed rate, cutting speed and depth of cut on machining mild steel using carbide cutting tools.

2. To determine CNC Lathe Turning optimum parameters setting for machining mild steel by utilization of Taguchi Method.

1.4 Scope of Project

This research investigate and analyze the relationship between surface roughness and machining parameter like feed rate, cutting speed and depth of cut in turning operation. Carbide cutting tool and mild steel will be use throughout this experiment. During this machining process, the machining parameters are set to 3 different values. Taguchi method was used as a tool to analyze and give the number of parameter that was run in this study. However, there are few things that will not be taken in consideration such as the cycle time which is the time taken in order to finish a product, the type of coolant that will be use in the experiment and the capability of the carbide cutting tool to produce the product. It is important to note that the mathematical modeling for this study will not provided and it was out of the scope. The experiment will be done using HAAS CNC turning machine. Each samples then planned to be analyzed using Surface Roughness Tester, SJ-301 at the UTeM Metrology Lab.

1.5 Report Outline

This report writing consists of six chapters. Chapters 1 describes about the introduction, which are include the background, problem statement, objectives, scope, and importance of the study. In the other hand, chapter 2 stressed on the literature review of related issues and chapter 3 highlighted more towards the methodology of the project, which is include the process planning, flowchart, data gathering method and analytical technique in the project. Chapter 4 is result analysis for experiment that will be done, while chapter 5 is consist discussion by refer to the result. Lastly, chapter 6 states the conclusion and recommendations to improve the experiment for next time.

1.6 Gantt Chart

Table 1.1: Gantt Chart for PSM 1

Gantt Chart PSM 1																				
No.	**Task**	**Week**																		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
1	Confirm project title and supervisor																			
2	Making planning progress by Gantt Chart																			
3	Discuss the objectives and scopes with supervisor																			
4	Writing up: Introduction																			
5	Find all informations, journal and references book																			
6	Meet and discuss the progress of PSM with supervisor																			
7	Writing up: Literature Review																			
8	Make flow chart for methodology																			
9	First draft submission																			
14	Complete the report and submit to supervisor																			
15	Preparation for oral presentation																			
16	Presentation PSM 1																			
Legend Indicator			**Planning**						**Actual**											