AN EXPERIMENTAL STUDY ON THE EFFECT OF TURNING PARAMETERS ON THE SURFACE ROUGHNESS OF AISI 1040 CARBON STEEL

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

By

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Sukacita dimaklumkan bahawa Laporan PSM yang tersebut di atas bertajuk **" An Experimental Study on the Effect of Turning Parameters on the Surface Roughness of AISI 1040 Carbon Steel"** mohon dikelaskan sebagai SULIT / TERHAD untuk tempoh LIMA (5) tahun dari tarikh surat ini.

Sekian dimaklumkan. Terima kasih.

Yang benar,

……………………………………………………..
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Pensyarah,
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DECLARATION

I hereby declare that this report entitled "An Experimental Study on the Effect of Turning Parameters on the Surface Roughness of AISI 1040 Carbon Steel" is the result of my own research except as cited in the references.

Signature :

Author's Name : **NOORFAZILAH BINTI MOHD ARSAD**

Date : 22 May 2009

APPROVAL

This PSM 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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(Prof. Dr. Mohd Razali Bin Muhamad)

....

Co-Supervisor

(Mr. Md Nizam Bin Abd Rahman)

ABSTRACT

Surface roughness plays an important role in product quality and how a real object will interact with its environment. The surface profile and roughness of a machined workpiece are two most important product quality characteristics for most mechanical products. The aim of this research is to find the significant parameters of turning process that affect the surface roughness. The model is developed in terms of cutting speed (CS), feed rate, and depth of cut (DoC). In this research, Precision Lathe Machine (MOMAC SPA) Model SM 200x1500 has been used to machine sample part (AISI 1040 carbon steel). For measurement, SJ-301 Surface Roughness Tester (Stylus Profilometer) will be used to determine surface roughness based on three factors that have been prescribed. Surface integrity and tool wear were analyzed using Metallurgical Microscope. Design of Experiment (DoE) will be used in order to study the relationship between these variables on surface roughness. The data will be analyzed using MINITAB 15 software. The result shows that cutting speed was the most significant factor that had affected the surface roughness (Ra) of medium carbon steel (AISI 1040).

ABSTRAK

Kekasaran permukaan memainkan peranan yang penting dalam menentukan kualiti sesuatu produk dan bagaimana sesuatu objek itu dapat berinteraksi dengan persekitarannya. Profil dan kekasaran permukaan sesuatu bahan kerja adalah dua perkara yang penting didalam kualiti sesuatu produk dan keperluan teknikal yang penting bagi produk mekanikal. Matlamat penyelidikan ini adalah untuk mengkaji parameter yang paling memberi kesan larikan keatas kekasaran permukaan. Kajian ini dilaksanakan atas beberapa faktor iaitu kelajuan pemotongan, kadar suapan dan kedalam pemotongan. Dalam kajian ini, Mesin Larik (MOMAC SPA) Model SM 200 x 1500 akan digunakan untuk pemesenan bahan ujikaji (besi karbon AISI 1040). Untuk pengukuran, alat Penguji Kekasaran Permukaan SJ-301 untuk menguji kekasaran permukaan bahan uji kaji berdasarkan tiga faktor yang telah ditetapkan. Tekstur permukaan bahan keja dan kehausan mata alat dikaji menggunakan Mikroskop Metalurgi. Rekabentuk Ujikaji (DoE) akan digunakan untuk mengkaji hubungan antara pembolehubah-pembolehubah yang digunakan pada kekasaran permukaan bahan ujikaji. Data-data yang terhasil akan dianalisis menggunakan perisian MINITAB 15. Hasil yang diperolehi darpada kajian menunjukan bahawa kelajuan pemotongan adalah parameter yang memberikan kesan paling besar pada kekasaran permukaan keluli karbon sederhana (AISI 1040).

DEDICATION

Special thanks I dedicate to my beloved family especially for my father (Mohd Arsad Bin Hj. Marzuki) and my mother (Sapariah Binti Othman). Thanks for all your love and support. I also would like to say thanks to all my friends for contributing to the success of my project. The successful of this project, cannot be achieved without all of you. Once again, thank you for everything.

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LIST OF ABBREVIATIONS

AA	-	Arithmetic Average
AISI	-	American Iron and Steel Institute
ANOVA	-	Analysis of Variance
ANSI	-	American National Standard Institute
ASME	-	American Society of Mechanical Engineers
BUE	-	Built-up Edge
C	-	Carbon
CLA	-	Center Line Average
cm	-	Centimeter
Co	-	Carbon monoxide
Cr	-	Chromium
CS	-	Cutting Speed
Cu	-	Copper
CVS	-	Constant Volume Sampler
D	-	Diameter
DIN	-	German Institute for Standardization
DoC	-	Depth of Cut
DoE	-	Design of Experiment
FR	-	Feed Ratez
ft	-	Feet
GPa	-	Giga Pascal
hp	-	Horse power
HSS	-	High Speed Steel
in.	-	Inches
ipr	-	Inches per revolution
ISO	-	International Organization for Standardization
JIS	-	Japanese Industrial Standard
kW	-	Kilowatt
LCD	-	Liquid Crystal Display
m	-	Meter

min.	-	Minute
mm	-	Millimeter
MPa	-	Mega Pascal
Ni	-	Nickle
R_a	-	Roughness Average
rev	-	Revolution
rpm	-	Rotation per minute
R_q	-	Root-mean-square (rms) Roughness
R_y	-	Maximum Peak-To-Valley Roughness Height
R_z	-	Arithmetic Mean
SAE	-	Society of Automotive Engineers
Si	-	Silicon
STM	-	Scanning Tunneling Microscopy
vs	-	Versus
X	-	Predictor variable
Y	-	Response variable
π	-	Pai
μm	-	Micrometer
%	-	Percent

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Metal cutting is one of the most significant manufacturing processes in the area of material removal (Chen and Smith, 1997). Black (1979) defines metal cutting as the removal of metal from a workpiece in the form of chips in order to obtain a finished product with desired attributed of size, shape, and surface roughness.

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 four factors that manufacturers must be able to control (Lahidji, 1997). Among various process conditions, surface finish is central to determining the quality of workpiece (Coker and Shin, 1996).

Surface roughness and tolerances are among the most critical measures in many mechanical products. As competition grows closer, customers now have increasingly high demands on quality, making surface roughness become one of the most competitive dimensions in today's manufacturing industry. Surface roughness also affects several functional attributes of parts, such as contact causing surface friction, wearing, light reflection, heat transmission, ability of distributing and holding a lubricant, coating, or resisting fatigue. Therefore, the desired finish surface is usually specified and the appropriate processes are selected to reach the required quality (Coker and Shin, 1996).

Several factors will influence the final surface roughness in turning operation. The final surface roughness might be considered as the sum of effects. Factors of effect such as spindle speed, feed rate, depth of cut, shape of cutting tool, material properties of booth tool and workpiece, tool wear, chip loads, chip formations, vibration of the machine tool, defects in the structure of the work material, or irregularities of chip formation contribute to the surface damage in practice during machining. Some of these factors are difficult to control.

Tools, workpiece and machine vibration, tool wear and tool material variability are the example of factors that difficult to control (Coker and Shin, 1996). However, there are some factor can be controlled to get the good surface roughness when machining. The factors can be controlled are cutting speed, depth of cut, and feed rate. These three factors can be use in machining process, otherwise lathe operation to get best result in surface roughness.

1.2 PROBLEM STATEMENT

Currently, in the turning process there are a few of condition part after machining. The condition of the part is by referring the accuracy of the dimension and surface roughness. The good surface roughness caused by many variables and the values of surface roughness cannot be realized without a good combination between the preferred parameter. For this analysis, the main effects are cutting speed, feed rate, and depth of cut. After machining process, the surface roughness shall give results depending on the cutting condition. Type of material used is AISI 1040 medium carbon steel. In order to study the problem, an analysis has carried out with help of previous study on the literature review where investigations into the effect of cutting conditions on surface roughness in turning, design of experiments (DoE) and other references for this analysis and research method has been implemented.

1.3 OBJECTIVE

The objectives of this study are:

a) To investigate a better understanding on the effects of turning parameter which are cutting speed (CS), feed rate, and depth of cut (DoC) through the surface roughness.
b) To identify the main influencing factor on the surface roughness.
c) To identify a well combination between the parameter to get a good surface of the AISI 1040.
d) To analyze the surface texture of the workpieces and tool wear of the cutting tools after machining operation.

1.4 SCOPE OF STUDY

This study is focusing on analyzing the turning parameter effect to the surface roughness of work piece. The parameters involved in these experiments are cutting speed, feed rate, and depth of cut. All the parameters in the variable values. Type of material used was AISI 1040 carbon steel. The insert carbide-cutting tool is used for all turning process. 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 (DoE) has been used in order to study the relationship between these variables on surface roughness. Surfaces roughness is measured by Mitutoyo Surface Roughness Tester SJ-301 (stylus profilometer), and the data presented are analyzed with the MINITAB software. The performance evaluated on tool wear and surface texture of AISI carbon steel will be analyzed by the Metallurgical Microscope Axioskop 2 Mat.

1.5 GANTT CHART

Table 1.1: Gantt chart PSM 1

No	Details		Week															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Confirm the Topic and discuss the Topic with supervisor	Planning	■															
		Actual	■															
2	Information search (related to the topic)	Planning		■	■	■	■	■	■	■	■	■	■	■	■			
		Actual		■	■	■	■	■	■	■	■	■	■	■	■			
3	Analyse the information and prepared the Chapter 1	Planning			■	■												
		Actual			■	■												
4	Submission of Chapter 1 * Introduction	Planning				■												
		Actual				■												
5	Preparation of Chapter 2	Planning				■	■	■	■									
		Actual					■	■	■	■	■							
6	Submission of Chapter 2 * Literature Review	Planning							■									
		Actual									■							
7	Preparation of Chapter 3	Planning							■	■	■	■						
		Actual										■	■	■				
8	Submission of Chapter 3 * Methodology	Planning										■						
		Actual												■				
9	Preparation of Draft Report	Planning										■	■					
		Actual												■				
10	Submission of Draft Report * Chapter 1, 2, 3 and Conclusion	Planning											■					
		Actual													■			
11	Edit the Draft Report (after check by Supervisor)	Planning											■	■	■			
		Actual														■	■	
12	Submission of Technical Repoart PSM 1 * Chapter 1, 2, 3 and Conclusion	Planning													■			
		Actual															■	
13	Submission of Logbook	Planning													■			
		Actual															■	
14	Preparation of Oral Presentation PSM 1	Planning													■	■		
		Actual															■	■
15	Oral Presentation PSM 1	Planning														■		
		Actual																■