UNIVERSITI TEKNIKAL MALAYSIA MELAKA

STUDY ON THE EFFECT OF THE DESIGN OF MACHINING PARAMETER ON SURFACE ROUGHNESS OF THE ALUMINUM ALLOY 7075 USING DESIGN OF EXPERIMENT (DOE)

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

by

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I hereby, declare this Final Year Project entitled
"Study on the effect of the Design of machining parameter on surface roughness of the Aluminum Alloy 7075 using Design of Experiment (DOE)"
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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 Design) with honours. The member of the supervisory committee is as follow:

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ABSTRACT

A set of experiments designed to begin the characterization of surface quality for the end-milling process have been performed. The objective of this study is to design CNC Milling program consist some parameter is spindle speed, feed rate and depth of cut on the surface roughness, to determine the optimal machining parameters to achieve the optimum surface roughness value for Aluminum Alloy 7075 under varying conditions, and to understand the programming of Design of Experiments (DOE) using Minitab software (full factorial). A common experimental design using Full Factorial type is one with all input factors set at two levels each. The result shows that there are eight runs for the experiment per material and each run for the experiment will use different value of parameter or factor. Such an understanding can provide insight into the problems of controlling the finish of machined surfaces when the process parameters are adjusted to obtain a certain surface finish. The model, which includes the effect of spindle speed, cutting feed rate and depth of cut, predicted the surface roughness values with an accuracy of about 12%. To predict the surface roughness occurs, the parameters will be use are spindle speed, depth of cut and feed rate. CNC machine will be use. Aluminum Alloy 7075 chosen as a workpiece's material and its dimension is 140mm x 120mm x20 mm.

ABSTRAK

Projek ini Adalah satu kajian untuk mendapatkan permukaan akhir dengan proses Milan yang telah dilakukan. Objektif daripada kajian ini adalah untuk melakukan program untuk Milling CNC terdiri dari beberapa parameter iaitu kelajuan pemotongan, kadar pemotongan dan kedalaman pemotongan untuk mendapatkan permukaan kasar, selain itu, untuk menentukan parameter mesin yang optimum untuk mencapai nilai permukaan kasar yang sesuai untuk Aluminum Alloy 7075 dalam keadaan yang berbeza-beza, dan Untuk memahami pengaturcaraan rekabentuk Eksperimen (DOE) dengan menggunakan perisian Minitab (full factorial). Dalam analisis projek ini dengan menggunakan kendalian perisian tersebut dengan semua parameter telah ditetapkan pada dua peringkat setiap parameter. Hasilnya menunjukkan bahawa terdapat 8 pusingan eksperimen setiap benda kerja dan masing-masing dilaksanakan untuk eksperimen dengan menggunakan nilai parameter yang berbeza-beza. Benda kerja yang merangkumi kesan daripada kelajuan pemotongan, kadar pemotongan dan kedalaman pemotongan, menganggarkan nilai permukaan kasar dengan ketepatan sekitar 12%. Untuk meramalkan permukaan kasar terjadi, parameter yang akan digunakan adalah kelajuan pemotongan, kadar pemotongan dan kedalaman pemotongan. CNC mesin akan digunakan dan Aluminium Alloy 7075 dipilih sebagai bahan eksperimen yang berukuran 140mm x 120mm x20 mm.

DEDICATION

To my beloved family especially my father and mother, En.Haji Ahmad Bin Haji Abdul Hamid and Pn.Usriah Bt Sadar, I thank my parents for their continuous support to me in performing this difficult task, and the journey does not end here.

To my supervisor, En Wahyono Sapto Widodo for being receptive and critical, and challenging me to be a better student

To my friend, for their sacrifice, encouragement, and support towards project accomplishment.

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LIST OF ABBREVIATIONS

DOE -	Design of Experiment
ANOVA	Analysis of Variance
CNC	Computer Numerical Control
UHMWPE	Ultra High Molecular Weight Polyethylene
RKPM	Reproducing Kernel Particle Method
Ra	Roughness average
AA	Arithmetic Average
CLA	Centerline Average
AFM	Atomic Force Microscope
ANNs	Artificial Neural Networks
RPM	Revolutions per Minute
Alclad	Available In the Clad
WOC	Width-Of-Cut
CAD/CAM	Computer Aided Design and Computer Aided Manufacturing

CHAPTER 1

INTRODUCTION

1.1 Background

Metal cutting is one of the most significant manufacturing processes in the area of material removal (Chen et al, 1997). Black 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 (J. T. Black, 1979). Surface roughness is an important measure of the technological quality of a product and a factor that greatly influences manufacturing cost. The mechanism behind the formation of surface roughness is very dynamic, complicated, and process dependent. The concept of roughness is often described with terms such as 'uneven', 'irregular', 'coarse in texture', 'broken by prominences', and other similar one. Similar to some surface properties such as hardness, the value of surface roughness depends on the scale of measurement. 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. The several factors influence the final surface roughness in end milling operation (G. Boothroyd et al, 1989). Parameter such as spindle speed, feed rate, and depth of cut that control the cutting operation setup is done in advance. However, some parameter such as tool geometry, tool wear, and chip formation, or the material properties of both tool and workpiece are uncontrolled (Kutner et al, 1990). Among several industrial machining processes, milling is a fundamental machining operation. End milling is the most common metal removal operation encountered. It is widely used in a variety of manufacturing industries including the aerospace and automotive sectors, where quality is an important factor in the production of slots and dies. The quality of the surface plays a very important role in the performance of milling as a good-quality milled surface significantly improves fatigue strength, corrosion resistance, and creep life. Surface roughness also affects several functional attributes of parts, such as wearing, heat transmission, and ability of 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. Several factors influence the final surface roughness in end milling operation (G. Boothroyd et al, 1989).

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 Alloy 7075 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.

1.2 Problem Statement

As a basic machining process, milling is one of the most widely used metal removal processors in industry and milled surface are largely used to mate with other part in die, aeroscope, automotive, and machinery design as well as in manufacturing industries.

Therefore, machine operators usually use "trial and error" approaches to set-up milling machine conditions in order to achieve the desired surface roughness. Obviously, the "trial and error" method is not effective and efficient and the achievement of a desirable value is a repetitive and empirical process that can be very time consuming.

The dynamic nature and widespread usage of milling operations in practice have raised a need for seeking a systematic approach that can help to set-up milling operations in a timely manner and also to help achieve that desired surface roughness quality.

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.

1.3 Objectives

i. To design CNC Milling program consist some parameter is spindle speed, cutting feed rate and depth of cut on the surface roughness.
ii. To determine the optimal machining parameters to achieve the optimum surface roughness value for Aluminum Alloy 7075 under varying conditions.
iii. To understand the programming of Design of Experiments (DOE) using full factorial application.

1.4 Scope

The scope of this project will cover to mainly research the performance in characterization of surface quality for the milling process including the definition of surface roughness, the material use and the properties of material that affect the performance of an industries. Type of material used was Aluminum Alloy 7075. In order to obtain desired surface roughness, 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. This study was having the limitation of the parameter that effect of machining parameters on the surface quality of the machined surfaces. The limitation of parameter is spindle speed, feed rate and depth of cut. When an experiment involves two or more factors, the factors can affect the response individually or interactally. The cutter used to execute the experiment, and for this profiling is cutter selected a four-flute end mill for tool size larger than diameter 10mm. When milling an internal contour, or concave external contours, the diameter is limited by the size of internal curves. The effects of cutting parameter on the surfaces finish on the surface machined of aluminum in range 1.29μm to 4.01μm.

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 end 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 DOE method on this experiment, the optimum of parameters speed will be obtain to produce the best surface finish.

1.7 Organization of the Project

The first chapter of this report is an introduction which provides a general background of surface roughness. Then it is followed by problem statement, objectives and scope.

The second chapter is literature review. The author reviews literatures on general background of surface integrity, important elements in material, performance of machining parameter, and other tools and methods used for product design.

The third chapter is methodology. It comprises information on developing method used to collect data. It is necessary to include a precise record of methods, materials and procedures used so as to enable other researcher to reproduce the research as well as to establish the reliability of the results.

The fourth chapter is experimental procedure. This chapter explain about how to set-up the CNC machine, step for use MasterCAM to generate the simulation and N-code.

The fifth chapter is result and discussion. The author analyzes and interprets the data collected. The data is discussed with help of graphs and tables using Design of Experiment (DOE).

The sixth chapter is the conclusion regarding the findings on the surface roughness in furniture industries. Then it is followed by recommendation and future research.

CHAPTER 2

LITERATURE REVIEW

This chapter is about how the parameters are selected and the proof from journal is attached .The machining, tool, workpiece properties and surfaces properties is also explained and show in this chapter.

2.1 Introduction

The effect of the design of machining parameter on surface roughness is already to literature by manufacturing researchers. Mostly the researcher have been literate about the Influence of Machining parameters on fatigue, Effects of Machining Parameters on Surface Quality of the Ultra High Molecular Weight Polyethylene (UHMWPE), Predictive modeling of surface roughness and tool wear in hard turning using regression and neural networks, An experimental investigation on the effect of turning parameters on surface roughness and the effect of Surface Roughness on the Pressure Required for Coupler Sealing. For this literature is related with machining parameter on surface roughness.

Surface roughness is mainly the result of process parameters such as tool geometry (i.e., nose radius, edge geometry, rake angle) and cutting conditions (feed rate, cutting speed, depth of cut). The impact of three factors, the feed rate, nose radius