UNIVERSITI TEKNIKAL MALAYSIA MELAKA

AN EXPERIMENT STUDY OF THE EFFECT OF CUTTING SPEED, DEPTH OF CUT AND FEED RATE TO ROUNDNESS IN CNC LATHE

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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2009

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PSM

TAJUK: **Study on Effect of Cutting Speed, Depth of Cut and Feed Rate to Roundness**

SESI PENGAJIAN: **2008/2009 Semester 2**

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DECLARATION

I hereby, declared this report entitled **"AN EXPERIMENT STUDY OF THE EFFECT OF CUTTING SPEED, DEPTH OF CUT AND FEED RATE TO ROUNDNESS IN CNC LATHE"** is the result of my own research except as cited in references.

Signature : .....

Author's Name : MOHD HAFIZ BIN ISMAIL

Date : 14 MAY 2009

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 member of the supervisory committee is as follow:

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ABSTRACT

This project entitled “An Experiment Study of The Effect of Cutting Speed, Depth of cut and Feed rate to roundness in CNC lathe” is contain about the effect of parameter on roundness and to get the best parameter setting for the CNC lathe machine in term of roundness. This project objective to investigate the contribution of the feed rate, cutting speed and depth of cut in CNC lathe machine at FKP machine shop laboratory by conducting several machining process and then analyzed the roundness of the finish product using CNC Roundness tester machine.

The overall effectiveness of this project needs methodology to collect the data, calculating the data and analyze the data. The collecting data is at all samples after the machining operation. After get the result, the data will test using CNC Roundness tester machine using least Square Circle Method. Then, the result will analyze using Design of Experiment (DOE) to get the contribution of parameter in roundness.

Finally, this study will also produce the best parameter setting and also verify the most effect parameter on roundness that need to be controlled. With this study and implementation on the machine it can the quality of the roundness.

DEDICATION

For my beloved mother and father

ACKNOWLEDGEMENT

First and foremost, I would like to express my highest appreciation to my supportive supervisor, Mr Amri bin Sulaiman for his supervision and support in completing this thesis.

Next I would like to dedicate my thankfulness and acknowledge to laboratory technicians, who has been so warmth and kind to provide sincere assistance and good cooperation during the training period. Their cooperation is much appreciated. . In addition, I would like to convey thanks to Miss Liew Pay Jun for her assistance, which really spends her time to teach me a lot of knowledge regarding to the DOE.

Last but not least, I would like to convey my appreciation to all the staff of Faculty of Manufacturing Engineering, FKP, my friend and colleagues for their support and their help in the project. Thank you.

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CHAPTER 1
INTRODUCTION

The purpose of this report is to study on three main controllable parameter that has to be consider in CNC lathe in term of roundness. The three main parameters are speed, depth of cut and feed rate. This study also determines which parameter has the big influence in roundness. In order to get the result several work piece will go through machining operation. The material that use is Aluminum 6161. During the operation the parameter will be change in every sample. The parameter are been setup by applying the Design of Experiment (DOE). After machining, the sample will be test using MAHr CNC Roundness Tester Machine. After that, all the roundness result will be compare again three parameters. From the result it will produce the standard parameter and from that also can know the parameter that effects the most in roundness.

1.1 OBJECTIVE

I. To investigate the contribution of feed rate, cutting speed and depth of cut in CNC lathe machine.
II. To analyzed the roundness of the finish product using CNC Roundness tester machine
III. To find the best parameter for aluminum 6061 and determine the relationship between the parameter and the roundness using Design of Experiment (DOE)
IV. To identify the parameter that effect the most in roundness

1.2 SCOPE

Scope of this project is conducting a machining operating using the CNC lathe machine to study the parameter in term of roundness. The machine that be used is CNC Lathe Machine Model Haas SL-20 manufactured by HAAS Automation Inc. The parameters that involve in this analysis are depth of cut; cutting speed and feed rate are set followed to the Design of Experiment (DOE).The material that used is solid cylinder aluminum 6061 with 30mm diameter. The other parameters are constant such as coolant and many more. The roundness test will be using the Mahr Formtester MMQ44 at the metrology lab and method that be used of each sample is least Square Circle Method. The result analysis will be done base on Factorial Design analysis using Minitab software.

1.3 PROBLEM STATEMENT

Roundness is one of geometrical tolerance that needs to be maintain when machining cylindrical part. To obtain good tolerance of roundness three controllable parameter need to be controlled. The parameters are depth of cut, speed (rpm) and feed rate that is setup by the operator in the program. However, the value of parameters depends on the size of the work piece to be machined. These controllable parameters are usually adjusted to get the fine quality of roundness.

Before this there are no appropriate parameters when cutting the aluminum 6061 in term of roundness. Hence, this study will develop the appropriate parameter for the CNC lathe machine model SL-20 for this material.

This experiment also tries to get which parameter that affects the most in cutting aluminum 6061. There is previous research that related to this study and therefore on this experiment try to verify those research.

CHAPTER 2

LITERATURE REVIEW

A literature review was conducted to gain knowledge about the roundness and parameter that effect in roundness using CNC lathe. There were a lot of articles about the cutting parameter and roundness but only the little is related with these researches. In additional to the literature search done at the library, discussion with those familiar with this project and gathered more articles from internet. Even the gathered research article is not directly to this project, it still helping reader for understanding these researches and also for their study. The literature review will include in the machine, roundness, material, parameter, Design of Experiment and roundness tester.

2.1 CNC lathe machine

2.1.1 CNC Lathe Machine Model Haas SL-20

For this PSM project will use CNC lathe model SL-20 series from Haas Automation that available in FKP laboratory. CNC lathes are designed to meet the needs of modern machine shops, now and long into the future. The SL Series offers a wide range of capacities, and our space-saving Big Bore option increases capacity further while retaining the original footprint. The SL-20, with a max turning capacity of 10.3" x 20" and an 8.3" chuck, has a bar capacity of up to 2.0".

SL- 20 high-performance turning centers also feature massive headstock castings with symmetric ribs for rigidity and thermal stability; on-the-fly wyes-delta switching for peak performance throughout the rpm range; and embedded chip trays and high-volume coolant systems for efficient chip removal. For control features advanced tool management, single-button features, 15-inch color LCD monitor and a USB port. With this feature it raised CNC turning to new levels of reliability, ease and productivity.

To simplify the ordering process, first determine the size of lathe needed to meet job requirements, and then select the options, such as a hydraulic tailstock, versatile live tooling, the automated Servo Bar 300 bar feeder, or the Big Bore option for larger bar capacity in the original footprint. Options may be ordered in pre-packaged groups, or selected individually for a custom configuration (Haas Automation Inc. 2008).

Figure 2.1 : CNC lathe machine SL-20 Series(Haas Automation Inc. 2008).

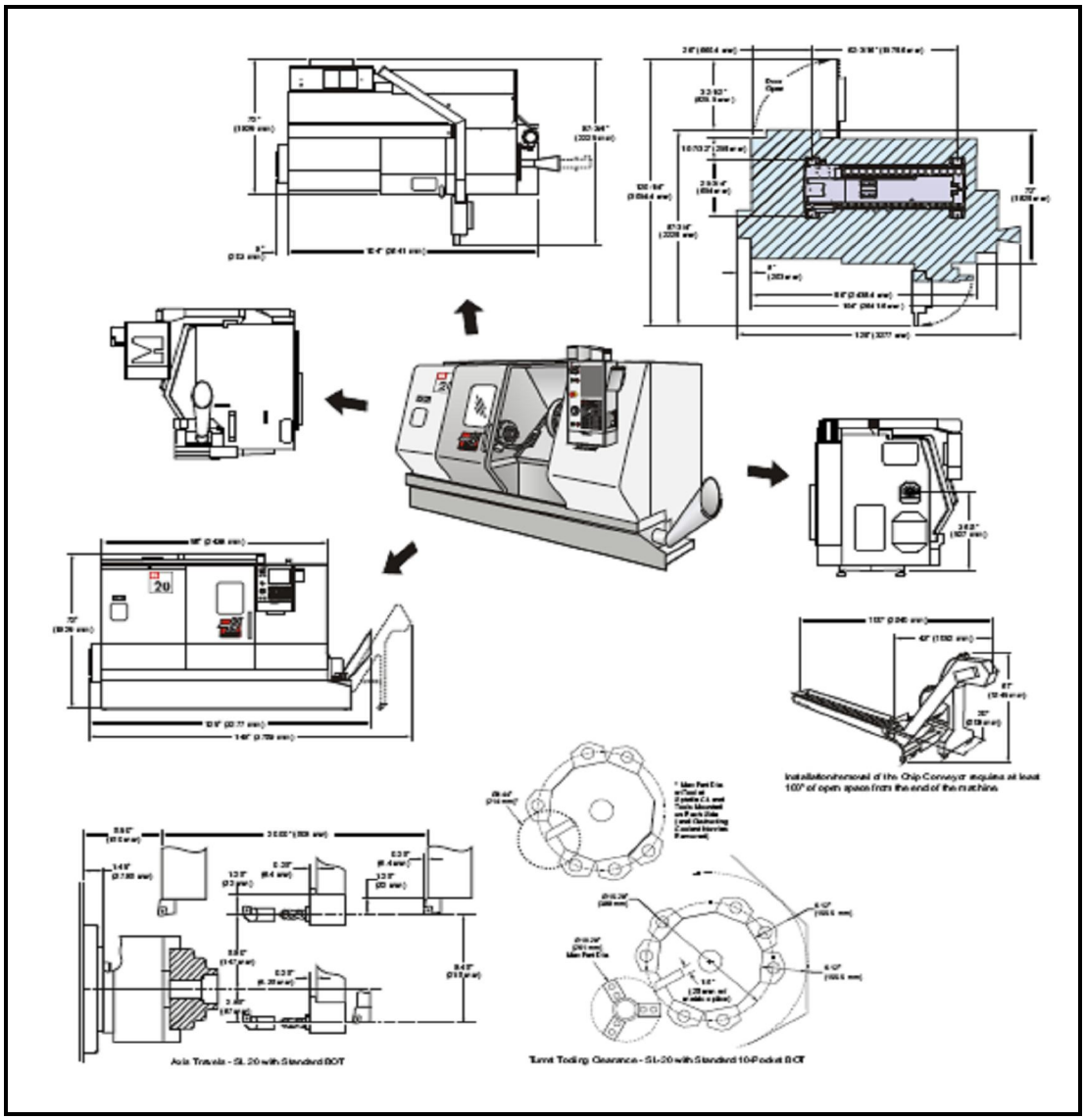

Figure 2.2: View for CNC lathe machine SL-20 series (Haas Automation Inc. 2008).

2.1.2 Machine specification

Table 2.1: The machine specification of CNC lathe machine Model SL-20 (Haas Automation Inc. 2008).

MAIN SPINDLE		
AVAILABILITY	Standard	
TURNING DIAMETERS	NOMINAL:--	MAXIMUM:--
TURNING LENGTHS	NOMINAL:10.000 "	MAXIMUM:10.000 "
MAXIMUM SWING	5.300 "	
CHUCK DIAMETER	STANDARD:--	MAXIMUM:--
BAR CAPACITY	0.875	
NOSE: A2-5	DRIVE MOTOR (HP): 8.0	

HEADSTOCK - SPINDLE 1	
NOSE: A2-6	**BORE:** 3.000 "
SPEED: 50 - 4000 RPM OPTIONS (top speed): • 3400 RPM • 5000 RPM • 7000 RPM	**DRIVE MOTOR (HP):** 20.0 OPTIONS: • 30.0
RANGE: 1	**INDEX INCREMENT (degrees):** 0.001

DIRECTION	Horizontal	
TURNING DIAMETERS	NOMINAL:8.000 "	MAXIMUM:8.200 "
TURNING LENGTHS	NOMINAL:15.000 "	MAXIMUM:16.300 " OPTION: 17.500
MAXIMUM SWING	23.000 "	
CHUCK DIAMETER	STANDARD:8.300 "	MAXIMUM:10.000 "
BAR CAPACITY	STANDARD:2.000 "	MAXIMUM:2.500 "

MAX. NUMBER OF SIMULTANEOUS CUTTING TOOLS: 1
MACHINE NET WEIGHT(pounds):9000

2.1.3 **Fundamental of CNC lathe cutting** (Graham T.smith, 2002)

There are two main factors influence a cutting process, which are independent variables and dependent variables. The dependent variables that are influences by changes in the independent variables such as:

- Force and energy dissipated in the cutting process.
- Temperature rise in the workpiece, the chip, and the tool.
- Wear and failure of the tool.
- Surface finish produced on the workpiece after machining.

The major independent variables in the cutting process are follows:

- Tool material, coating, and tool condition.
- Tool shape, surface finish, sharpness.
- Work pieces material, condition, and temperature.
- Cutting parameter such as speed, feed rate, and depth of cut.
- Cutting fluid.
- The characteristic of machine tool, such as its stiffness and damping.
- Work holding and fixtures.

2.2 Roundness

In all manufacturing process roundness is one of the important things. In order to get the best roundness it affected by lot of factors like cutting tool, depth of cut, cutting speed, feed rate, type of material, coolant and many more. Roundness or out of roundness can be as the radial deviation of the actual profile from the ideal roundness. When the parameters are not selected properly it will effect the roundness of the product. If the

speed increase and feed decreases, loss of precision in roundness tends to increase (Engineering statistic handbook, 2007)

2.2.1 Roundness measurement

The measurement of roundness can be made by two ways. The first way is to use Coordinate measuring machine (CMM) and the second one is using MAHr Roundness Tester Machine. Using roundness tester machine the machine will compare the roundness from the product with actual sample roundness result. Three measurement of roundness were taken at different location.

2.2.1.1 Method in Measure Roundness

Measurements of roundness require 360° traces of the workpiece made with a turntable-type instrument or a stylus-type instrument. A least squares fit of points on the trace to a circle define the parameters of noncircularity of the workpiece. A diagram of the measurement method is shown below (Engineering statistic handbook, 2007).

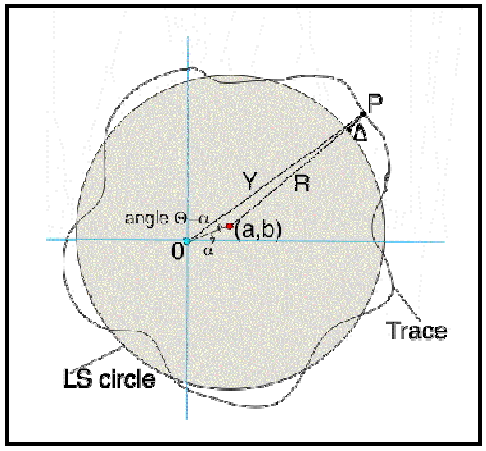

Figure 2.3: The diagram shows the trace and Y, the distance from the spindle center to the trace at the angle (Engineering statistic handbook, 2007)

They are four reference circles are internationally accepted for roundness measurements. They are:

i. Maximum radius inscribing circle (MIC);[6] The MIC is the largest circle just contained by the profile of a work piece. It is also known as the plug gauge circle and is intended for shafts (Guru S.M and Tsai D.M, 1998).

- A circle is drawn within all the data and is expanded until it is constrained by three valleys (David Whitehouse, 2002).
- The center obtains by this method need not to be unique (David Whitehouse, 2002).
- For this method there is ambiguity if there are two equally good centers like in the dumbbell shape (David Whitehouse, 2002).

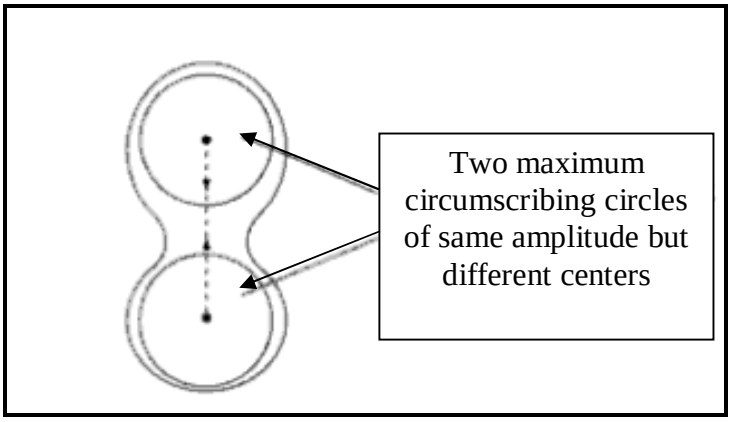

Figure 2.4: Problem with plug gauge method (Engineering statistic handbook, 2007)

ii. Minimum radius circumscribing circle (MCC) (Guru S.M and Tsai D.M, 1998).

- The MCC is the smallest circle that just contains the profile of a work piece. It is also known as the ring gauge circle and is intended for holes (Guru S.M and Tsai D.M, 1998).

- A circle is drawn around all the data and then shrunk onto to the data to get the minimum size circle (David Whitehouse, 2002).
- This has to have just three point of contact between the data and the circle (David Whitehouse, 2002).