THE STUDY ON THE EFFECTS OF CUTTING PARAMETERS IN NEAR END CUTTING SPEED NORMAL RANGE MACHINING

ZARIAH BINTI ZAINUDIN

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE STUDY ON THE EFFECTS OF CUTTING PARAMETERS IN NEAR END CUTTING SPEED NORMAL RANGE MACHINING

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

ZARIAH BINTI ZAINUDIN

FACULTY OF MANUFACTURING ENGINEERING

2009

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PSM

JUDUL: **THE STUDY ON THE EFFECTS OF CUTTING PARAMETERS IN NEAR END CUTTING SPEED NORMAL RANGE MACHINING**

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

Saya **ZARIAH BINTI ZAINUDIN**

mengaku membenarkan laporan PSM / tesis (Sarjana/Doktor Falsafah) ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM / tesis adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM / tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. *Sila tandakan (√)

☐ SULIT (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia yang termaktub di dalam AKTA RAHSIA RASMI 1972)

☐ TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

☐ TIDAK TERHAD

(TANDATANGAN PENULIS)

Alamat Tetap:
Lot 281, Kg Kuau,
16300, Bachok,
Kelantan Darul Naim

Tarikh: 16/04/2009

(TANDATANGAN PENYELIA)

Cop Rasmi:

Tarikh: ______________________

* Jika laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
Karung Berkunci 1200, Ayer Keroh, 75450 Melaka
Tel : 06-233 2421, Faks : 06 233 2414
Email : fkp@kutkm.edu.my

FAKULTI KEJURUTERAAN PEMBUATAN

Rujukan Kami (Our Ref) : 11 Mei 2009
Rujukan Tuan (Your Ref):

Pustakawan
Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM)
Taman Tasik Utama, Hang Tuah Jaya,
Ayer Keroh, 75450, Melaka

Saudara,

PENGKELASAN LAPORAN PSM SEBAGAI SULIT/TERHAD
- LAPORAN PSM SARJANA MUDA KEJURUTERAAN PEMBUATAN (PROCES PEMBUATAN): ZARIAH BINTI ZAINUDIN
TAJUK: THE STUDY ON THE EFFECTS OF CUTTING PARAMETERS IN NEAR END CUTTING SPEED NORMAL RANGE MACHINING

Sukacita dimaklumkan bahawa tesis yang tersebut di atas bertajuk **"THE STUDY ON THE EFFECTS OF CUTTING PARAMETERS IN NEAR END CUTTING SPEED NORMAL RANGE MACHINING"** mohon dikelaskan sebagai terhad untuk tempoh lima (5) tahun dari tarikh surat ini memandangkan ia mempunyai nilai dan potensi untuk dikomersialkan di masa hadapan.

Sekian dimaklumkan. Terima kasih.

"BERKHIDMAT UNTUK NEGARA KERANA ALLAH"

Yang benar,

…………………………………………………..
EN.MOHAMMAD KAMIL BIN SUED
Pensyarah,
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka(UTeM)
Karung berkunci 1200, Ayer Keroh,
75450, Melaka
06-2333454

DECLARATION

I hereby, declared this report entitled **"THE STUDY ON THE EFFECTS OF CUTTING PARAMETERS IN NEAR END CUTTING SPEED NORMAL RANGE MACHINING"** is the result of my own research except as cited in references.

Signature	:	…………………………………………
Author's Name	:	….ZARIAH BINTI ZAINUDIN……...
Date	:	…………………………………………

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:

(Signature of Supervisor)

………………………………

(Official Stamp of Supervisor)

ABSTRACT

High Speed Machining is found to be effective in machining. In this study, an attempt to study the near end normal cutting speed range is done. The cutting speed range selected are between 300m/min to 600m/min. The other parameters that are cutting tool, feed rate and depth of cut also considered in this study. The design of experiment using Taguchi Method L_9 orthogonal array is implemented to help the construction of the study and to minimize number of experiments. The analysis is done based on the smaller the better in order to obtain best parameters in producing smooth surface roughness. It is found that feed rate and cutting speed strongly affecting the surface roughness followed by depth of cut. With minimum setting of cutting speed, feed rate and depth of cut the minimum flank wear is produced.

ABSTRAK

Pemesinan halaju tinggi didapati berkesan dalam pemesinan. Dalam kajian ini, pembelajaran tentang kadar halaju potongan yang lebih tingi dari halaju biasa dibuat. Halaju potongan yang dipilih antara 300m/min sehingga 600m/min. Pembolehubah lain seperti mata alat, kadar uluran, dan kedalaman potongan juga diberi perhatian dalam kajian ini. Rekabentuk ujikaji yang digunakan adalah kaedah Taguchi yang membantu merekabentuk ujikaji dalam kajian ini dan meminimakan bilangan eksperimen yang perlu dibuat. Analisis dibuat berdasarkan yang kecil adalah lebih baik untuk mendapatkan permukaan yang licin. Didapati kadar uluran dan halaju potongan memberi kesan yang kuat kepada permukaan dan diikuti oleh kedalaman potongan. Dengan meminimakan halaju potongan, kadar uluran dan kedalaman potongan akan meminimumkan kehausan permukaan yang terhasil.

DEDICATION

For my beloved family and friends

ACKNOWLEDGEMENT

This project and the writing of this report has been a culmination for my studies in Universiti Teknikal Malaysia Melaka (UTeM). Many challengers have been faced during this project but at the same time it has been very interesting and rewarding.

Now that I am finishing this project, I would like to express my gratitude especially to my supervisor, Mr. Muhammad Kamil bin Sued, for his constructive comments, ideas, support and guidance throughout this project.

Besides that, I would like to say my gratefulness to the technicians of CNC laboratory, Mr Fauzi and Mr Jaafar which had given the advice when handling the machine and to provide the material and cutting tool needed for the machining operation.

Finally, many thanks to my family and all my friends for their endless support and energy they have given me during my studies.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AA	-	Arithmetic Average
AlCrN	-	Aluminium Chromium Nitrade
CLA	-	Center Line Average
CNC	-	Computer Numerical Control
CVD	-	Chemical Vapor Deposition
DOC	-	Depth of Cut
DOE	-	Design of Experiment
HSM	-	High Speed Machining
HSS	-	High Speed Steel
MRR	-	Material Removal Rate
PVD		Physical Vapor Deposition
Ra	-	Average Roughness
RPM	-	Rotation Per Minutes
S/N	-	Signal Noise
TiC	-	Titanium Carbide
TiN	-	Titanium Nitrite
WC	-	Tungsten Carbide

CHAPTER 1

INTRODUCTION

1.1 Background

Among the most effective and efficient modern manufacturing technologies, high speed machining (HSM) is employed to increase the productivity while simultaneously improving product quality and reducing manufacturing costs. High speed machining allows higher productivity, excellent surface finish and good dimensional accuracy in the manufacturing process. Therefore this technology has considerable advantages over traditional machining technologies (Canter, 2007).

The advantage of using high cutting speed is enables to machine harder material, in low cutting force. The surface roughness can down to 0.1 micron and it can reduce burr formation and cycle times. High speed machining successfully used in aircraft and automotive industry for machining complex elements made of aluminum and alloys. HSM also widely used in the optical industry such as precision machining and fine mechanical parts. The challengers of using high speed machining are with higher acceleration and deceleration rates, spindle start and stop which resulting faster wear of guide way, ball screws and spindle bearings. Thus will lead to higher maintenance costs. To reduce the disadvantage of high speed machining, the users need to have specifics process knowledge, programming of the equipment and interfaces for fast data transfer (Schulz and Moriwaki, 1992). Research on high speed of machining involves a wide variety of work materials ranging from easy-to-cut aluminum alloys (Schulz *et al.* 2001) to difficult-to-cut hardened steels (Quan, 2004).

In high cutting speed, surface roughness is one of the important factor for evaluating workpiece quality because the quality of surface roughness affects the functional characteristics of the workpiece such as compatibility, fatigue resistance and surface friction. Surface roughness is mainly affected from the process parameters such as tool geometry and cutting parameters. For tool geometry there are nose radius, edge geometry and rake angle and for cutting parameters there are feed rate, depth of cut and cutting speed. Roughnesses are obtained from the measurement on the surface of the workpieces. The quantification is done by the vertical deviations of a real surface from its ideal form. If these deviations are large, the surface is rough and if the deviations are small the surface is smooth. The deviations considered to be represented by the surface roughness (Ra) unit which it in high frequency with short wavelength. The roughness takes the average of the peaks and valleys over a given length during measurement. There are two methods assessing surface roughness either by contact or noncontact method.

While machining process, the contacts between the workpieces with cutting tool will give an effect to the surface roughness of the workpieces and cutting tool. A cutting tool is any tool that is used to remove metal from the workpiece by means of shear deformation. In order to perform a long time, cutting tools must be made of a material harder than the material which is to be cut, and the tool must be able to withstand the heat generated in the metal cutting process. Also, the tool must have a specific geometry, designed so that the cutting edge can contact the workpiece without the rest of the tool dragging on the surface of the piece part surface. The angle of the cutting face is also important as is the flute width, tool margin and tool material. Most lathe operations are done with relatively simple, single-point cutting tools. On right-hand and left-hand turning and facing tools, the cutting takes place on the side of the tool; therefore the side rake angle is of primary importance and deep cuts can be made. The back rake angle affects the ability of the tool to shear the work material and form the chip. It can be positive or negative. Positive rake angles reduce the cutting forces resulting in smaller deflections of the workpiece, tool holder, and machine. Tool forces vary with cutting speed, feed rate, depth of cut and rake angle. If the back rake angle is too large, the strength of the tool is reduced as well as its capacity to conduct heat. In machining hard work materials, the back rake angle must be small, even negative for carbide and diamond tools.

During machining, cutting tool remove material from the component to achieve the required shape, dimension on surface roughness. However wear occurs during the cutting action, it will ultimately results in the failure of the cutting tool. When the tool wear reached a certain extent, the tool or active edge has to be replaced to guarantee the desired cutting action. Tool life of the cutting tool determined by the amount of wear that has occurred on the tool profile which reduces the efficiency of cutting to an acceptable level, or eventually causes tool failure. Tool life is affected by many variable related to the material used, the machining variable, and the machining conditions. The cutting speed, feed, depth of cut, tool material, tool form, condition of the machine and the condition under which the tool engages and disengages from the work are some material variables that effects the tool life. Some condition of the temperature of the work and tool, the ability of the system to dissipate heat the chip geometry, the forces required to remove chip and the feet rate (Lin, 2008).

1.2 Problem Statement

The use high of cutting speed in industry has become more prevalent in recent year. In most manufacturing industries, the smooth surface is usually the objective in machining besides setting the part followed to the design required. The milling process for high speed machining is more common than turning process, but in this study turning is chosen to understand it effect during the machining and as the contribution to the knowledge. The cutting parameters will influence the surface quality of workpiece produced. The suitable values of cutting parameters need to be studied to get appropriate result of surface roughness that depends on the applications. To prevent wear tools used during machining, the tool wear need to be studied. At high cutting speed, the fine surface roughness can be rapidly obtained by proper machining setting.

1.3 Objectives of the Project

The objectives of this study are:

a) To determine the effects of cutting parameters on the surface roughness at near end normal cutting speed range machining.

b) To study the effects of coated and multilayer coated on surface roughness.

c) To study the tool performance of uses cutting tools.

d) To propose the suitable cutting parameters at near end normal cutting speed that able to produce smooth surface roughness.

1.4 Scope of the Project

In this project, due to the machining capabilities constrains, the cutting speed used is near end normal cutting speed range machining as use in the conventional machining setting. The cutting parameters had taken to the considerations are cutting speed, depth of cut (DOC) and feed rate. The experiment setup will base on the, design of experiment (DOE), Taguchi method L_9 orthogonal array. The material use is aluminium 6061. Two types of cutting tools, coated carbide and multilayer coated are used in this study. Besides that, the tool wear is also being observed.

CHAPTER 2

LITERATURE REVIEW

In the year of 2008, Ahmed presents a methodology for selecting optimal machining process parameters to obtain the required surface roughness. A carbide tool is used to machine a commercial aluminium workpiece on an AmcoTurn120P CNC lathe without any coolant. The speed used is 600 rpm, 800 rpm and 1000 rpm. The feed rate used is 80,120 and 160 mm/min. The depth of cut use is 0.25, 0.5, 1.0 mm. The best result produced when used speed of 1000rpm, feed rate at 80m/min and depth of cut of 0.25mm. The surface finish obtained from the setting is 0.40µm and where the surface roughness is 0.63µm. In this paper, it is showed that at higher speed, smaller feed would smooth the surface (Ahmed, 2006).

In 1979, McGee in his work with aluminium note that the tool chip interface temperature increased with cutting speed up to a maximum which is equal to the melting point of the workpiece. The plot curve did not show a decline in temperature as Salomon suggested. Rather it increased approaching the melting range of aluminium. The rating range fall much below the maximum temperature that most present day tool material can be with stand. This explains why aluminium is an ideal candidate for ultra high speed machining. The maximum cutting speed in the machining of aluminium is imposed by machine tool technology (McGee, 1978).

In the study on “High speed Machining of Aluminium Alloy and Steel 37”, the effect of high cutting turning velocities is studied by turning Aluminium alloy LM21 (Si 6%, Cu 4%) bars on a centre lathe using a high speed steel tool. The workpiece material is machined orthogonally using wide range of cutting speeds, feeds, and depths of cut, while the tool geometry is kept constant during the experiments. The experimental results showed that by increasing the cutting velocity from 120 m/min to 600 m/min, the cutting forces as well as the specific cutting energies are decreased by about 53 % of their values. The surface finish is also improved tremendously by that increase in cutting velocity (El Chazly, 1996).

Dr. Sinan Badrawy, Principal Engineer Cincinnati Machine, A UNOVA Company, do a research on Cutting dynamics of High Speed Machining. For Dr. Badrawy who has conducted extensive research in dynamic vibration analysis, it's all in the chips. The material used is aluminium. Aluminium is one of the easiest metals to cut, which makes machining it a competitive challenge to the industry. Higher spindle speeds and machine feed rate, combined with a greater depth of cut, increases the metal removal rate and productivity. As a result, the manufacturer of aluminum parts faces not only limitations of the machine and tool, but also the dynamic characteristic of the spindle, toolholder and tool system. Under these conditions, the top spindle speed may not be the best speed for achieving the highest productivity. The maximum spindle speed is usually a good starting point. Chip load doesn't strongly influence chatter. Any reasonable value will do during testing so long as the same chip load is used for every cut. The radial depth of cut can be picked arbitrarily. For the axial depth of cut, start light and keep increasing, cut after cut, until chatter sets in. there will be some spindle speeds at which it's possible to perform much deeper cuts without chatter. Armed with these data, programmers can know what spindle speed and maximum depth of cuts to specify for which combination of machine, toolholder and cutting tool (Badrawy, 2001).

In year 2005, Bauzid study about the carbide and ceramic tool life in high speed turning use five different types of commercially available inserts to turn an AISI 4340 steel at speeds between 300 m/min and 1,000 m/min. The flank wear is measured for different inserts in connection to cutting time and for different values of cutting speed. It is shown that for carbide tools, an increase in cutting speed causes higher decrease of tool life. This is due to the thin width of the coat layer, and once the coating film is peeled off, the soft substrate of the insert becomes uncovered and the wear grows rapidly. For ceramic insert, the tool life takes high values even for high values of cutting speed. Tool life is defined using wear criterion value, which depends on cutting speed. The investigation included the realization of wear model in relation to the time. Also, empirical model have been developed for tool life determination in connection with cutting speed. On the basis of obtained results, it is possible to set optimal conditions to achieve the maximum tool life (Bauzid, 2005).

As a conclusion from the previous research on turning operation, a low value of surface roughness results get when using high cutting speed. Results obtained through previous experiment confirm the advantage of high of cutting speed over conventional machining. Based on aluminium as a workpiece, High speed of milling is the machining process widely used in industries. But for others material such as tool steel and aluminium alloy, HSM turning operation is not widely available. In this project, a speed of machining turning on aluminium is going to investigate the cutting parameters effects on surface roughness and tool performance. For high speed turning operation, tungsten carbide is usually used. In this project, the speed used is at high end of normal range as shown in Figure 2.1. The material used is aluminium. For the cutting tools, coated carbide and multilayer coating are used. For the study, the parameters are based on the previous studies which possible range of settings are selected

2.1 High Speed of Machining

High-speed machining may be defined in various ways. High of cutting speed regards to attainable cutting speeds, it is suggested that operating at cutting speeds significantly higher than those typically utilized for a particular material may be termed in Figure 2.1.

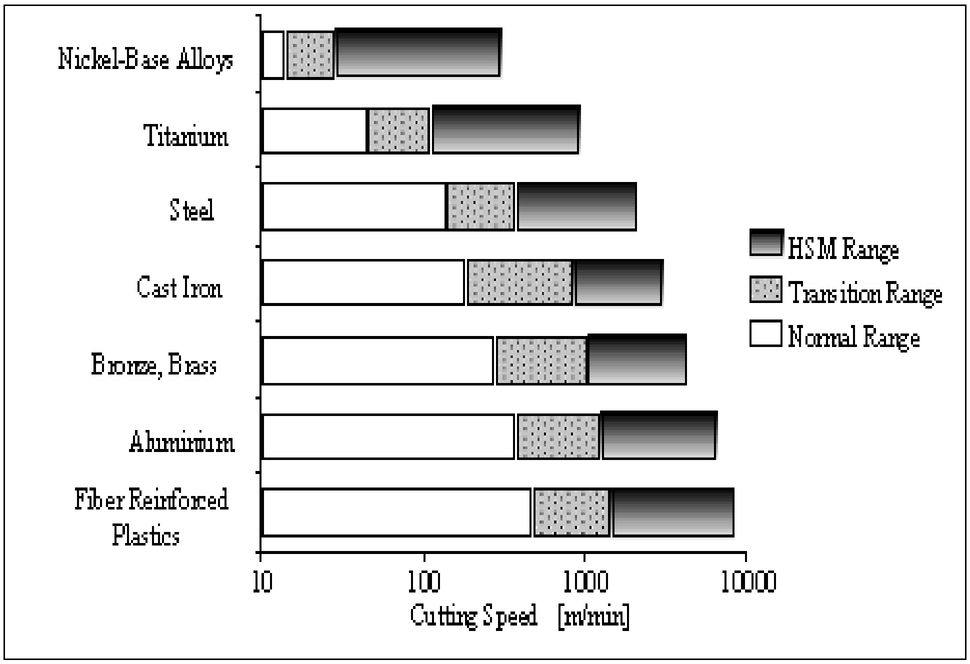

Figure 2.1: HSM for different material (Schulz, 1992).

The term high in HSM is somewhat relatives as a general guide an approximate range of cutting speed may be defined as follows (Kalpakjian and shmid, 2006):

a. 30.5 m/min : Low speed conventional industrial machining

b. 30.5-610m/min : Conventional industrial machining

c. 610 – 1830 m/min : High speed machining

d. 1830 -18300 m/min : Very high speed machining

e. 18300 -152400 m/min: Ultra high speed or Ballistic particle machining