UNIVERSITI TEKNIKAL MALAYSIA MELAKA

PERFORMANCE ANALYSIS OF DIFFERENT SHAPE OF INSERT FOR TURNING OPERATION

Thesis submitted in accordance with the requirements of the
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Bachelor of Engineering (Honors) Manufacturing (Process)

By

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DEDICATION

For my supervisor, lecturers, family and friends

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PERFORMANCE ANALYSIS OF DIFFERENT SHAPE OF CARBIDE INSERT FOR TURNING OPERATION

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APPROVAL

This thesis submitted to the senate of UTeM and has been accepted as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process). The members of the supervisory committee are as follow:

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Main Supervisor

(Official Stamp & Date)

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Co-Supervisor

(Official Stamp & Date)

DECLARATION

I hereby, declare this thesis entitled “Performance Analysis of Different Shape of Carbide Insert for Turning Operation” is the results of my own research except as cited in the reference.

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Date	:	…28…MARCH…2008.......

ABSTRACT

Determination of suitable insert cutting tool shape and relief angle in turning operation is particular importance due to its controlling the quality of the machining parts and also influence on the tool life. Numerous attempts have been made to approach the problem with different methods including experimental, analytical and also numerical analysis. This research presents the performance of carbide insert with variety of shape and nose angle in turning AISI 1045 Mild Steel and AISI H13 Tool Steel. The surface roughness values were obtained using Mitutoyo's surface tester to evaluate the inserts in a three type of turning operation (roughing, finishing and light roughing / semi finishing). The smaller of nose angle on insert contribute to a good surface roughness for finishing process. The results show that surface roughness increased due to increased of the nose angle on combination of high spindle speed and low feed rate. Rough turning is characterized by the used of low spindle speed and high feed rate. The smaller nose angle is not suitable for this kind of process due to high surface roughness value on the workpiece.

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CHAPTER 1

INTRODUCTION

Tool geometry parameters play an important role in determining the overall machining performance, including cutting forces, tool wear, surface finish, chip formation and chip breaking. The importance of optimizing tool geometry has been highlighted recently to be of enormous economic significance in maximizing tool life in machining. Over the past few decades, many investigations have been made to study the important effects of tool geometry, including tool inclination angle, on machining performance. It is well known that the tool inclination angle is a major factor in determining the chip flow direction in machining and has been used in various mathematical models of chip flow. In finish turning process, a well-controlled tool inclination angle can effectively guide the chip to flow in a desired direction to reduce the risk of chip entanglement and protect the machined surface, thus achieving effective chip control in automated machining systems.

Nearly all turning processes use single point cutting tools, which mean the tools that cut with only a single edge in contact with the workpiece. Most turning process is done with coated indexable carbide inserts, but the tool material can be high-speed steel, brazed carbide, ceramic, cubic boron nitride, or polycrystalline diamond. Generally, most of turning operations use just a few basic tool geometries. When turning with inserts, much of the geometry is built into the tool holder itself rather than the actual insert. The geometry of an insert includes the insert's basic shape, its relief or clearance angle, the insert type, the insert's nose radius, and the insert's chip breaker design.

In turning, insert shape selection is based on the trade-off between strength and versatility. The larger point angles are stronger, such as round inserts for contouring and square inserts for roughing and finishing. The smaller angles (35° and 55°) are the most versatile for complex work. Turning inserts may be molded or ground to their working shape. The molded types are more economical and have wide application. Ground inserts are needed for maximum accuracy and to produce well defined or sharp contours.

Several angles are important when introducing the cutting tool's edge into a rotating workpiece. These angles include the angle of inclination, rake angle, effective rake angle, lead or entry angle, and tool nose radius. Since a sharp edge is weak and fractures easily, an insert's cutting edge is prepared with particular shapes to strengthen it. Those shapes include a honed radius, a chamfer, a land, or a combination of the three.

1.1 Objectives

i. To study the performance of different shape of carbide insert in turning operation especially roughing and finishing process.
ii. To study the relationship between the surface roughness value and turning parameters such as spindle speed and feed rate.

1.2 Scope of project

i. This research is about to investigate and analyzed the different shape and relief angle of cutting tool in turning operation.
ii. There are three type of insert shape with different nose angle were selected to perform the project. There are diamond shape with 80° and 35° nose of angle, triangle shape with 60° of nose angle, and square shape with 90° of nose angle.
iii. The insert carbide cutting tool was used for all the machining process.
iv. There are two type of workpiece material selected to perform the experiment which are AISI H13 tool steel and AISI 1045 mild steel.
v. The experiment was done by HAAS Lathe Machine in a room temperature using three types of operation machining; roughing, finishing and light roughing/semi finishing.
vi. During this machining process, several cutting parameters remain constant such as depth of cut, 1.5 mm, and length of cut, 30mm.
vii. The Surface Roughness Tester, SJ-301 branded Mitutoyo America Corporation was used to analyze and identified the surface of the machined workpiece.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This literature review will discuss thoroughly about the matter that related to the analysis of different shape and angle relief for turning operation. The topics that reviewing are about the lathe machine components, the machining operation, type of cutting tool in turning process, tool ware and failure of cutting tool, and surface integrity. The different shape and angle relief of cutting tool will be discussed and how this parameter influence in turning operation.

Cutting tools for metal cutting have many shapes, which each of them are described by their angles or geometries. Every one of these tool shapes has a specific purpose in metal cutting. The primary machining goal is to achieve the most efficient separation of chips from the workpiece and produce a good surface finish. For this reason, the selection of the right cutting tool geometry is critical.

2.2 Lathe Components

Lathes are equipped with a variety of components and accessories (Kalpakjian, 2006). Figure 2.1 show that the components and the accessories of lathe machine, which including the bed, carriage, headstock, and tailstock.

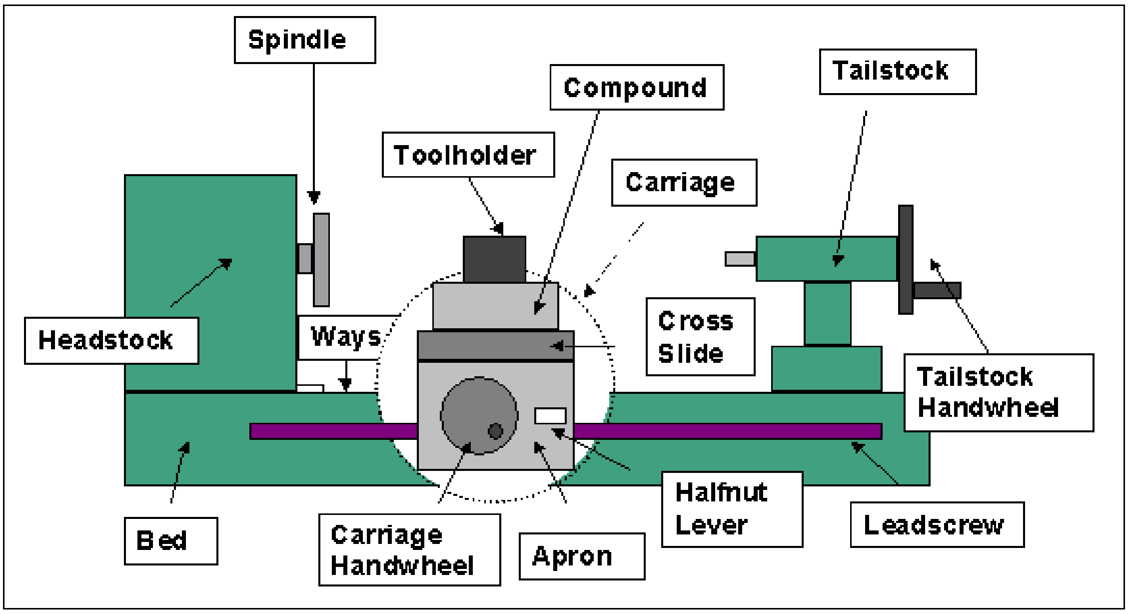

Figure 2.1: Various components and accessories of the lathe machine. (Frank J. Hoose Jr., 2000)

2.2.1 The Basic Part of The Lathe Machine

i. Bed

This part provides support for the other units of the lathe. The V-shaped ways are located on the top of the bed providing alignment of the headstock, bed and tailstock. The top portion of the bed has two ways, with various cross-sections, that are hardened and machined accurately for wear resistance and dimensional accuracy during use.

ii. Carriage

The carriage provides the means for mounting and moving cutting tools. The carriage, relatively flat H shaped casting rides on the outer ways on the bed. The cross slide is mounted on the carriage and can be moved by means of a feed screw that is controlled by a small handwheel and graduated dial. This provides a means for moving the lathe tool in the facing or cutoff direction.

iii. Headstock

The main elements contains at the headstock are the gears, pulleys and the combination of both. Besides that, it also contains the motor, spindle speed selector, feed-unit selector and feed-direction selector. The headstock provides support and rotation to the work piece by attaching a work-holding device to its spindle. It's also have a hollow spindle to which work holding devices, such as chucks and collets, are attached, and long bars can be fed through for various turning operations.

iv. Tailstock

It can slide along the ways and can be clamped at any position, supporting the other end of the work piece. It is equipped with a center that may be fixed (dead center), or it may be free to rotate with the work piece (live center). Drills and reamers can be mounted on the tailstock quill to produce axial holes in the work piece. A hand wheel allows for the extension of the tailstock spindle.

2.3 Machining Operation (Turning)

The turning process is the major process that involved in this project. This process basically defined as machining of an external surface of the workpiece and produces a cylindrical form according to size that we set. During this operation, the tool is stationary while the metal is rotate. The majority of turning operation involves the use of simple single-point cutting tools, with the geometry of a typical right-hand cutting tool (Kalpakjian, 2006).

As illustrated in greater detail in Figure 2.2, the cutting tool is set at a certain depth of cut (mm or in) and travels to the left with a certain velocity as the workpiece rotates. The feed or feed rate is the distance the tool travels horizontally per unit revolution of the workpiece (mm/rev). This movement of the tool produces a chip, which moves up the face of the tool.

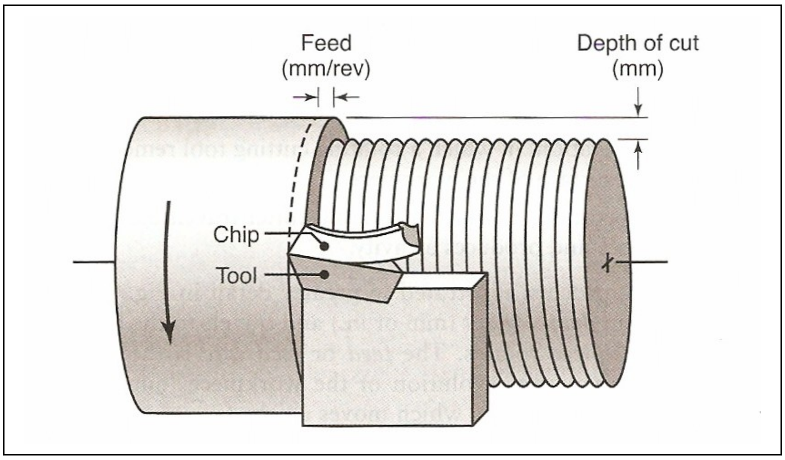

Figure 2.2: Schematic illustration of the turning operation showing various features (Kalpakjian, 2006)

According to George Schneider Jr., in general sense, the term ‘turning’ refers to the generation of any cylindrical surface with a single point tool. More specifically it is often applied just to the generation of external cylindrical surfaces oriented primarily parallel to the workpiece axis. The generation of surfaces oriented primarily perpendicular to the workpiece axis are called ‘facing’. In turning the direction of the feeding motion is predominantly axial with respect to the machine spindle. In facing a radial feed is dominant. Tapered and contoured surfaces require both modes of tool feed at the same time often referred to as ‘profiling’ (George Schneider Jr., 2005). The turning, facing and profiling operation are shown in Figure 2.3.

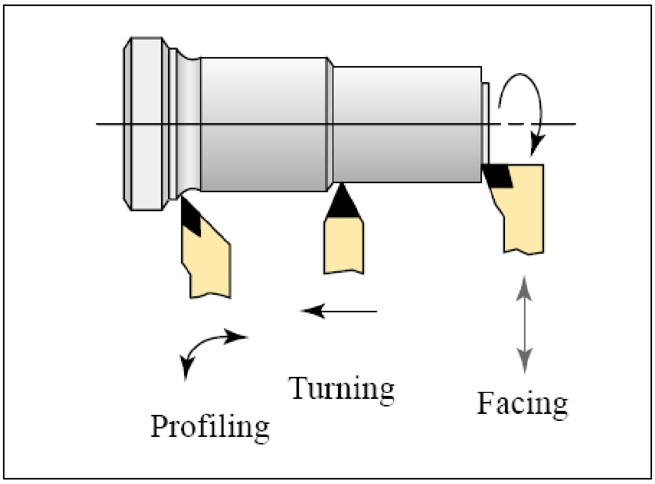

Figure 2.3: Diagram of the most common lathe operations. (George Schneider Jr., 2005)

2.3.1 Related Turning Operations

Single point tools are used in most operations performed on a lathe. A variety of other machining operations can be performed on a lathe in addition to turning and facing. These include the following, as shown in Figure 2.4.

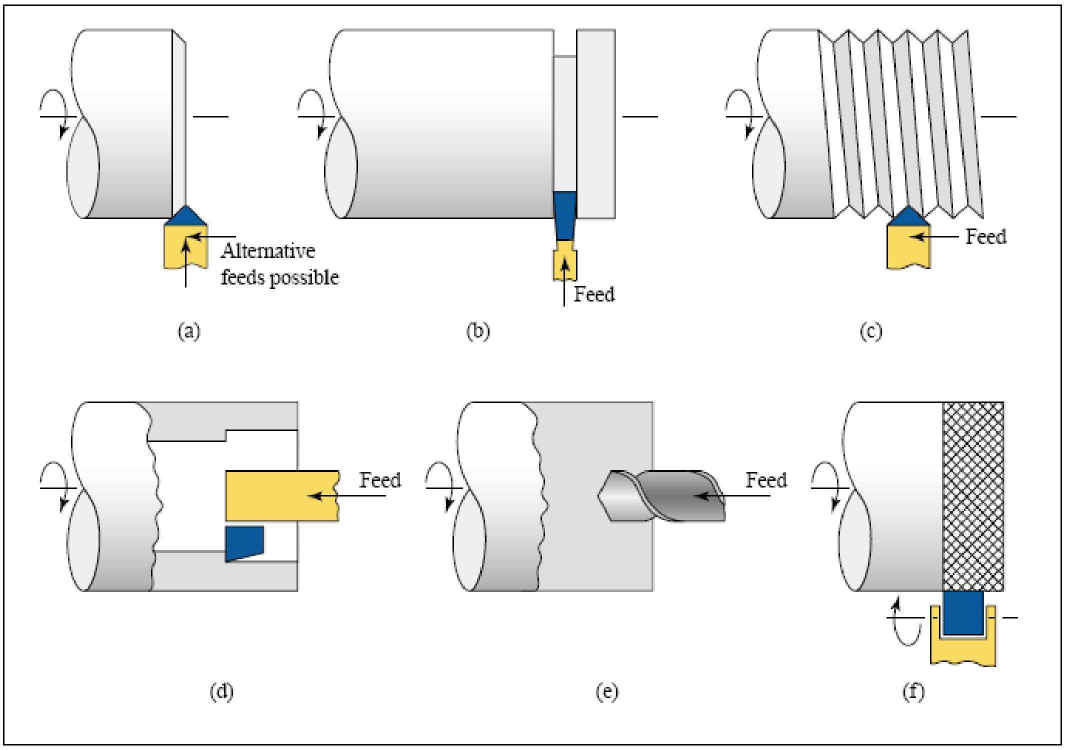

Figure 2.4: Related turning operations: (a) chamfering, (b) parting, (c) threading, (d) boring, (e) drilling, (f) knurling (George Schneider Jr., 2005)

i. Chamfering: The tool is used to cut an angle on the corner of a cylinder.

ii. Parting: The tool is feed radially into rotating workpiece at a specific location along its length to cut off the end of a part.

iii. Threading: A pointed tool is fed linearly across the outside surface of rotating parts to produce external or internal threads.

iv. Boring: Enlarging a hole made by a previous process. A single point tool is fed linearly and parallel to the axis of rotation.

v. Drilling: Producing a hole by feeding the drill into the rotating work along its axis. Drilling can be followed by reaming or boring to improve accuracy and surface finish.

vi. Knurling: Metal forming operation used to produce a regular crosshatched pattern in work surfaces.

2.4 Mechanics of Cutting

In general, machining is 3D process for providing an understanding of mechanics of machining, we simplify the process into 2D process called as orthogonal cutting as shown in Figure 2.5. In the orthogonal cutting, the workpiece is a flat piece and is machined using a wedge-shaped tool with a *rake angle* (α) and *a relief angle* (θ). The workpiece is moving at a *cutting speed* (V) with a *depth of cut* (d) to remove the material. The width remains unaffected. Merchant has developed an analysis based on the classical thin zone mechanics for materials that yield continuous chip with planar shear process. The following assumptions were made:

1) The tool tip is sharp and no rubbing occurs between the tool workpiece
2) Plain strain conditions such as there is no side spread and therefore the deformation is two dimensional
3) The stresses on the shear plane are uniformly distributed

The resultant force on the chip applied at the shear plane is equal, opposite and collinear to the force applied which is the force applied to the chip at the tool-interface.