A STUDY ON MACHINING STRATEGIES FOR POCKETING PROFILES: OUTWARD HELICAL, OFFSET ON PART ONE WAY AND OFFSET ON PART ZIGZAG

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A STUDY ON MACHINING STRATEGIES FOR POCKETING PROFILES: OUTWARD HELICAL, OFFSET ON PART ONE WAY AND OFFSET ON PART ZIGZAG

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

by

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…….

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ABSTRACT

A pocket machining can be defined as any machining that removes all material located inside a boundary between two horizontal planes. Circular and rectangular shapes were the pockets investigated. In this research, machining strategies is defined as the path that a cutting tool traverse in order to remove material as created a shape. An experimental investigated was conducted to explore surface finish machining strategies of outward helical, offset on part one way and offset on part zigzag in producing pocket shape. Otherwise, this research is conducted to study the effect of roundness accuracy in applying different machining strategies of outward helical, offset on part one way and offset on part zigzag and to make recommend theory for best machining strategy based on the obtained result in machining pocket profiles. In this research, cutting parameters were remained constant for all parts. This included the length of the tool reach, feed rate, spindle speed and depth of cut. CNC Milling 3-Axis machine and Aluminium 6063 were used in performing the physical machining. Methods to test the machined parts in this research were Surface Roughness Testing by using Mitutoyo Surface Roughness Test Machine and Roundness Measurement using of Coordinate Measurement Machine (CMM) Zhafir Contura 2. The results reveal that offset on part one way was the best for surface roughness analysis and offset on part zigzag shown better accuracy when roundness measurement was carried out. Implications of the results and future research directions are also presented.

ABSTRAK

Pemesinan poket boleh ditakrifkan sebagai apa-apa pemesinan bahan yang membuang semua berada di dalam sempadan antara dua satah mendatar. Bentuk bulat dan segi empat tepat adalah dalam poket yang disiasat. Strategi pemesinan adalah jalan satu alat pemotong untuk mengeluarkan bahan untuk mewujudkan bentuk. Eksperimen telah dijalankan untuk meneroka strategi pemesinan kemasan permukaan heliks ke luar, mengimbangi di pihak sehala dan mengimbangi di pihak dalam menghasilkan poket bentuk zigzag, kesan ketepatan bulat dalam menggunakan strategi pemesinan berlainan luar heliks, mengimbangi di pihak satu cara dan mengimbangi teori zigzag bahagian dan untuk mengesyorkan strategi pemesinan terbaik berdasarkan keputusan yang diperolehi dalam profil pemesinan poket. Dalam kajian ini, parameter pemotongan adalah berterusan untuk semua bahagian. Ia termasuk panjang jangkauan alat, kadar suapan, kelajuan gelendong dan kedalaman pemotongan. Mesin pengilangan 3-paksi CNC dan A 6063 yang digunakan dalam kajian ini. Kaedah untuk menguji bahagian mesin dalam kajian ini ialah Kekasaran Permukaan dan Pengukuran Dimensi. Hasilnya menunjukkan bahawa ofset pada bahagian satu adalah cara yang terbaik untuk analisis kekasaran permukaan dan mengimbangi di pihak zigzag adalah ukuran bulat lebih tepat menggunakan ujian. Implikasi keputusan dan arahan kajian akan datang turut dipersembahkan.

DEDICATIONS

I dedicated this thesis to my beloved parents who have always been my nearest and educated me to reach this level.

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LIST OF SYMBOLS AND ABBREVIATIONS

SBM	=	Shape-Based Matching
CNC	=	Computer Numerical Control
CAD	=	Computer Aided Design
CAM	=	Computer Aided Manufacturing
FE	=	Finite Element
AI	=	Aluminium

CHAPTER 1
INTRODUCTION

1.0 Introduction

This chapter shows the overview about the topic of this research. It includes of background of research, statement of the problem, objectives and scopes of project.

1.1 Background

Pocketing profiles are contributed into large industry as automotive and aerospace. Pocket is a typical and common operation on CNC machining centers. [14] A pocket machining can be defined as any machining that removes all material located inside a boundary between two horizontal planes. Pockets can be square, rectangular, round or undefined shape that can be empty inside or they may have island. In this study, circular and rectangular shape of pocket will be investigating. Circular pocket is chosen due to automotive industry which much of their parts in circular shape especially for bearing, disk break and car rim. Meanwhile, rectangular shape are really famous in aerospace industry because of their properties of parts that need to be light and high stresses. [1]

Machining strategies is the path that a cutting tool traverse in order to remove material as created a shape. It includes of helical, outward helical, inward helical, back and forth, zigzag, spiral, one-way next, one-way same, contour only and concentric.[2] This research will be focusing on three types of strategies that is outward helical, offset on part one way and offset on part zigzag. Outward helical is machining occur with a motion start from a point inside the domain and follow paths parallel to the domain boundary away from the center of the domain. Offset on part

one way is machining occur with a motion start in a direction and offset on the part one way. Offset on part zigzag machining occur with a motion start in a direction and offset on the part zigzag. The three types of strategies are chosen because of its more suitable to machine pocketing parts. [15]

CNC Milling 3-Axis machine and Aluminium A 6063 will be used in this research. In CNC machine, the control unit contains a dedicated computer which uses the data provided in the part program to control the machine tool. The complete program to produce a component is input and stored within the memory computer and calculating of work or tool movements.

CADCAM is combination of CAD and CAM. Computer-aided design (CAD) is defined as the application of computers and graphics software to aid or enhance the product design from conceptualization to documentation. Computer-aided manufacturing (CAM) is defined as the effective use computer technology in manufacturing planning and control. This combination allows the transfer of information from the design into the stage of planning for the manufacturing of a product, without the need to reenter the data on part geometry manually. CATIA V5 is a one of software in CADCAM. This software will be utilized to modify part and preparing the CAM program.

Methods to test the machined parts in this research are Surface Roughness and Dimensional Measurement. Surface roughness is use to measure the quality of surface based on R_a, R_y and R_z. Dimensional measurement represent very responsible part of the machines, therefore they require very thorough, full analysis of accuracy. It is not enough just to measure their diameters or positions, it is crucial to measure their out of roundness as well. [3]

1.2 Statement of the Problem

Efficient manufacturing of pocketing parts is an important issue due to large industry as automotive and aerospace. A common problem in CAD/CAM is to find suitable strategies for milling pockets that is defined by a shape in the plane. [4] The demand for high quality of pocketing part on the surface condition of the product, especially the roughness of the machined surface, because of its effect on product appearance, function, and reliability. For these reasons it is important to maintain consistent accuracy and surface finish.

1.3 Objectives

The aims of this study are:

i. To investigate the effect of surface finish at different machining strategies in rectangular and circular pockets.
ii. To observe the capability of various machining strategies applied in producing the best dimensional accuracy for rectangular and circular pockets.
iii. To suggest the best machining strategy in machining rectangular and circular pockets based on the obtained results.

1.4 Scope of Project

This project used CADCAM software namely CATIA V5 to modify the part and CAM process. CNC Milling Machine 3-Axis and Aluminium A6063 were used for machining process. Besides, three different strategies were applied to machine the parts. They were outward helical, offset on part one way and offset on part zigzag. Other than that, rectangular and circular of pocketing profile were used for three selected machining strategies mentioned before. In analysis, Surface Roughness and Dimensional Measurement particularly roundness were analyzed to get data.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

References and understanding were gained from various sources that are journals, books and internet. The focus in this literature is about different machining strategies on pocketing profile. Machining strategies that been discuss in this topic are Outward Helical, Offset on Part One Way and Offset on Part Zigzag. A 6063 as a selected material are explained on the mechanical properties and application.

2.1 CNC Machine

CNC Milling Machine is chosen in this research because of pocketing profile is more preferred to machine using milling process. CNC machining is used to produce a wide range of components, and tooling costs involved have continued to become more affordable. In general, large production runs requiring relatively simple designs are better served by other methods, although CNC machining accommodate a wide range of manufacturing needs. CNC milling is ideal solutions to everything ranging from prototyping and short-run production of complex parts to the fabrication of unique precision components. [13]

According to Romero P.E. (2013), more than 80% of all mechanical parts can be machined using milling. This is because most of them consist of faces parallel to a single plane, and that free form objects are usually produces from a raw stock by roughing and finishing. Roughing represents 50% of the total machining time, although it can be five to ten times longer than finishing. There are two popular tool

path strategies in pocket milling which are contour-parallel and direction parallel. The contour parallel path is operating by offsets of the input profile. The direction of parallel path uses line segments that are parallel to an initially reference line selected and it simple process than the contour parallel path. The strategy chosen to generate the tool path can influence the parameters of machining that are machining time, cutting forces, length of the tool path and surface roughness. [6]

2.2 CNC Milling Machine

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2.3 Pocket Milling

Pocket machining represents an important area in the machining of mechanical parts, dies, and moulds. Pockets can be in form of rectangular, roundness, square and others complex shape. It also can either on open or closed pocket.

According to Gang F. (2008), pocket dies commonly used in the manufacturing of solid aluminium profiles. In extrusion and tooling industries, the design of pocket dies depends on the experience of the designer. The design of die that has pocket becomes more challenging when it used for the manufacturing of a wide thin-walled profile. [7]