MACHINING PROCESS DESIGN AND COSTING - MILLING OPERATION

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MACHINING PROCESS DESING AND COSTING (MILLING OPERATION)

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

by

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ABSTRAK

Tajuk projek ini ialah "Pembangunan rekabentuk proses pemesinan interaktif dan pengiraan masa pemesinan untuk operasi mesin “milling” ". Projek ini akan membincangkan tentang kaedah untuk mengira kitaran masa pemesinan dan kos yang terlibat dalam proses pemesinan. Pengiraan kitaran masa pemesinan dan kos adalah penting untuk membuat perancangan yang baik untuk pengeluaran terutamanya untuk produk baru. Kaedah yang sedang digunakan untuk mengira kitaran masa pemesinan dan kos dianalisis dan akan dibandingkan dengan kaedah yang akan dicadangkan. Perisian berasaskan excel akan dihasilkan sebagai kaedah yang dicadangkan untuk mengira kitaran masa pemesinan dan kos. Perisian yang akan dihasilkan akan merangkumi pemilihan proses pemesinan, pemilihan mata alat bersama dengan elemen lain untuk menghitung masa pemesinan. Selepas itu kos pemesinan akan dikira daripada masa yang kita dapatkan dari pengiraan kitaran masa pemesinan dengan tambahan kos lain seperti kos alat dan kos bahan, kos tidak langsung dan sebagainya. Perisian ini akan membantu untuk mengurangkan beban kerja bagi orang yang bertanggungjawab untuk membuat perancangan pengeluaran. Perisian ini akan dibina secara interaktif untuk membuat penggunaan perisian menjadi lebih mudah.

ABSTRACT

The “Development of interactive machining process design and machining time calculation for milling process” project. This project will discuss on the method to calculate the machining time and the cost involved in the machining process. The calculation of the machining time and cost is important in order to make a good planning for the production especially for a new product. The current method to calculate the machining time and cost is analyzed and will be compared with the proposed method. The excel based software will be develop as a proposed method to calculate the machining time and cost. The software will include the selection of machining process, selection of tooling along with the other time element to calculate the machining time. After that, the cost involve in the machining process will be calculated from the time that result from the calculation with the addition of other cost like tool and material cost, indirect cost and etc. This software will help to reduce the workload for the one whom responsible to make the production planning. This software will be built in interactive way to make the software usage easier.

DEDICATION

For my beloved parents

Mr. Mohd Ibrahim Merican Bin Mohd Ismail Merican

Mrs Noriyah Binti Haris

For my supportive siblings

Mohd Izham Merican & Wife

Nor Saedah & Husband

Nor Hafizah & Husband

And my treasured friends

BMFU

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CAD	-	Computer Aided Design
CAM	-	Computer Aided Manufacturing
CM	-	Centimeter
CNC	-	Computer Numerical Control
HSS	-	High Speed Steel
m	-	Meter
m/min	-	Meter Per Revulutions
min	-	Minute
mm	-	Milimeter
mm/rev	-	Milimeter Per Revolutions
NC	-	Numerical Control
No.	-	Number
PSM1	-	Projek Sarjana Muda 1
PSM2	-	Projek Sarjana Muda 2
Rev	-	Revolutions
Rev	-	Revolution
RPM	-	Revolutions Per Minute
sfm	-	Surface Feed Per-Minute

CHAPTER 1

INTRODUCTION

Chapter 1 will give a brief explanation about this project, starting with the background of the project title, "Development of interactive machining process design and machining time calculation". This chapter will also discuss about the problem statement, the objectives and the scope and limitation for this project.

1.1 Background

Nowadays, metal machining had become one of the important processes in manufacturing field. As it become important, the company that use metal machining processes need to make a production plan in order determine the acquisition, utilization and allocation of production resources to satisfy customer requirements in the most efficient and effective way. The examples of the important matters for the production planning are the machining time and the machining cost. Machining cost estimation is important and critical in manufacturing industries. There are major differences between what Western and Japanese manufacturing executives expect from cost information and how they utilize it. A manager in Europe or the United States has been known generally to use cost information to make decisions about pricing and investments, while a Japanese manager expects to use cost information to control costs (Tanaka, T. 1993). From the need to calculate the machining cost, there come the machining time calculation as with the machining time and cost per unit time for the processes, the machining cost can be estimated. Machining time and

cost can be estimated completely after a machining process plan is built. In machining processes, machines, processes, cutting tools and operation sequences are needed to make a process plan. There are many method can be used to calculate the machining time and cost before the production of the certain product started. Normally people calculate the machining time manually and referring to the standard, handbook, and machine manual before starting the production. This project will be made base on the purpose to make the work to calculate the machining time and cost easier for the production planning.

1.2 Problem statement

Machining time and cost calculation for machining process using manual way is a difficult method to determine the machining time and cost and can be considered as a time consuming. Nowadays, the machining time and cost is calculated using manual method and sometimes the machining time and cost are estimated based on the experience and not calculated properly. The problems to calculate the machining time and cost using manual method are;

(a) Time consuming.

(b) There are only few people know the method of calculating the machining time and machining cost that result to the estimation of the machining time and machining cost that are not so accurate.

(c) Since calculating the machining time and machining cost require a lot of reference such as standard, manual, and handbook, it makes this work very troublesome and tedious. The purpose of this research and development is to introduce user friendly software using interactive way of calculating the machining time and machining cost.

In order to solve the problem, this project is to develop software to calculate the machining time and cost of machining process so that the manual method can be replaced by this software and ultimately make the work easier.

1.3 Objectives

Based on the title "Development of interactive machining process design and machining time calculation", the objectives to be achieved at the end of this project are as below;

(a) To study the manual method used to calculate machining time and cost

(b) To develop a user friendly excel-based software using interactive way to calculate the machining time and machining cost.

(c) To compare between the manual method of calculating the machining time and cost with the software made.

1.4 Scope and limitation

This project will develop excel-based software to calculate the machining time and machining cost and the calculation are only limited to milling machining only. For the machining process selection, this software will only be limited to side milling, face milling, chamfering, drilling, slotting , boring, reaming and threading. The material that can be chosen using this software will be limited to low carbon, medium carbon, high carbon, aluminums casting and iron casting. For the tool selection, the tool will be limited to high speed steel, carbide and ceramic. The other metal machining process, material and tools will not be included in this software thus will not be covered in this project.

1.5 Outline of report

Generally, this report is divided into two part which are Projek Sarjana Muda (PSM I) and (PSM II). The total report contains of five chapters . these chapters generally discusses about back ground of study, problem statement, scope, as well as the limitation of the study and research methodology.

Chapter two is the literature review which will done based on journals, books. Internet recourse and previous studies done related to this topic. Based on information gathered this chapter will discuss the milling machines, processes, cutting tools and operation sequences for milling machine in order to know the element used to calculate the machining time and cost.

Chapter three, the all method to construct the research and phase to developing a software are explained. On the other hand, Chapter 4 is about process to developing the software to estimate the machining time and machining cost. On this chapter, a detail step by step process to develop the software will be explained.

In the last chapter conclusion and recommendation which summary and the conclusion for the project of developing the interactive machining process design and machining time calculation software and also some suggestion to improve this study for the future. Finally , all the chapter are complied separately in sequence in oder to give a clear view to the readers

CHAPTER 2

LITERATURE REVIEW

This chapter will explained about all the elements used for this report. First explanation will come to the machines, processes, cutting tools and operation sequences for milling machine in order to know the element used to calculate the machining time and cost. After that, the conventional method to calculate the machining time and cost is explained. The computerized system is also explained in this chapter.

2.1 Milling Machining

Milling is the process of machining flat, curved, or irregular surfaces by the work piece against a rotating cutter containing a number of cutting edges. usual mill consists basically of a motor driven spindle, which mounts and revolves the milling cutter, and a reciprocating adjustable worktable, which mounts and feeds the work piece. (Oberg, E. Jones E. D. 2008)

Milling machines are basically classified as vertical or horizontal. These machines are also classified as knee-type, ram-type, manufacturing or bed type, and planer - type. Most milling machines have self-contained electric drive motors, coolant systems, variable spindle speeds, and power-operated table feeds. (Oberg, E. Jones D. 2008)

A milling machine is a machine tool that cuts metal with a multiple-tooth cutting tool called a milling cutter. The work piece is fastened to the milling machine table and is fed against the revolving milling cutter. The milling cutters can have cutting teeth on the periphery or sides or both. (Oberg, E. Jones E. D. 2008)

Milling machines can be classified under three main headings:

(a) General Purpose machines - these are mainly the column and knee type (horizontal & vertical machines).
(b) High Production types with fixed beds- (horizontal types).
(c) Special Purpose machines such as duplicating, profiling, rise and fall, rotary table, planetary and double end types.

Milling is one of the most versatile and one of the machine tools that have been widely used by people all over the world. Milling machine is commonly known as the mother of all other machine tool. Many complicated operations such as indexing, gang milling, and straddle milling can be carried out on a milling machine. (Oberg, E. Jones 2008)

The advance of modern technology and a new generation of manufacturing equipment, particularly computer numerical control (CNC) machine, have brought enormous changes to the manufacturing sector. Generally, the handbook or human experience is used to select convenient machine parameters in manufacturing industry. In process planning of conventional milling, selecting reasonable milling parameters is necessary to satisfy requirements involving machining economics, quality and safety. (M. Tolouei-Rad 1997).

The machining parameters in milling operations consists of cutting speed, depth of cut, feed rate and number of passes. These machining parameters significantly impact on the cost, productivity and quality of machining parts. The effective optimizations of these parameters affect dramatically the cost and production time of machined components as well as the quality of final products. (M. Tolouei-Rad 1997).

Nowadays, the manufacturing industries has been equipped with either manually controlled or CNC millings for their production. The reason why C N C milling machine had been used widely in manufacturing machining industry is because of the versatility that is the automatic tool changer. The automatic tool changer of milling machine can change the tools between different machining operations without any user intervention. With this key of versatility, several machining operations can be executed in a single work piece setup. CNC milling if classified according the axis of work piece movement, it can be divided into horizontal CNC milling and vertical CNC milling. For this study, it will focus on vertical CNC milling however this software is also applicable to the C N C horizontal milling.

2.1.1 Processes

There are plenty of processes that can be done on milling machine and the processes are, end mill, chamfering, face mill, drilling, sinking threading, boring and etc. For all the processes, there are some general rules to follow regarding the sequence of machining operation in order to do more than one processes to one product. The details for all the processes will be explained by following the sequence.

2.1.1.1 End mill

End milling is are very common machining operation because of the capability to produce various profiles and curved surface. The cutters mounted into the spindle of milling machine and usually its rotates on axis perpendicular the work piece surface. The end mill makes either peripheral or slot cuts, determined by the step-over distance, across the work piece in order to machine a specified feature, such as a profile, slot, pocket. The depth of the feature may be machined in a single pass or may be reached by machining at a smaller axial depth of cut and making multiple passes. (Kalpakjian 2006)

2.1.1.2 Chamfering

A chamfer end mill makes a peripheral cut along an edge of the work piece or a feature to create an angled surface, known as a chamfer. This chamfer, typically with a 45 degree angle, can be machined on either the exterior or interior of a part and can follow either a straight or curved part.

2.1.1.3 Facemill

In face mill, the cutter is mounted on a spindle having an axis of rotation perpendicular to the work piece surface in the manner of conventional or climb milling. The cutter rotate at a rotational speed and the work piece move along a straight path at linear speed. A number of cutting teeth such as carbide insert are mounted on the cutter body, so the feed is using feed per teeth. (Kalpakjian 2006)

2.1.1.4 Drilling

A drill enters the work piece axially and cuts a hole with a diameter equal to that of the tool. A drilling operation can produce a blind hole, which extends to some depth inside the work piece, or a through hole, which extends completely through the work piece. (Kalpakjian 2006)

2.1.1.5 Boring

A boring tool enters the work piece axially and cuts along an internal surface to form different features. The boring tool is a single-point cutting tool, which can be set to cut the desired diameter by using an adjustable boring head. Boring is commonly performed after drilling a hole in order to enlarge the diameter or obtain more precise dimensions. (Kalpakjian 2006)

2.1.1.6 Reaming

A reamer enters the work piece axially and enlarges an existing hole to the diameter of the tool. Reaming removes a minimal amount of material and is often performed after drilling to obtain both a more accurate diameter and a smoother internal finish. (Kalpakjian 2006)

2.1.1.7 Threading

Threading operations actually involves cutting a helical groove of definite shape or angle, with a uniform advancement for each revolution, either on the surface of a round piece of material, or inside cylindrical hole (Miller R. and Miller M. R., 2004). A tap enters the work piece axially and cuts internal threads into an existing hole. The existing hole is typically drilled by the required tap drill size that will accommodate the desired tap. Threads may be cut to a specified depth inside the hole (bottom tap) or the complete depth of a through hole (through tap). (Kalpakjian 2006)

2.1.2 Cutting Tools

The selection of proper tooling for the process that wants to be made is important in order to make sure the production is successful. Normally the selection of tools to produce a specific work piece is a responsibility of tool engineer, machining process planner or programmer in case of the NC millings. It is essential for the person responsible for tools selection to have a clear understand about the process and the material used.

2.1.2.1 High speed steel

The advantages of High Speed Steel (H SS) Tool

(a) HSS costs less than carbide or ceramic tooling.
(b) HSS is less brittle and not as likely to break during interrupted cuts.
(c) The tool can be re-sharpened easily.

Disadvantages of High Speed Steel Tool

(a) HSS does not hold up as well as carbide or ceramic at the high temperatures generated during machining.
(b) HSS does not cut hard materials well.

2.1.2.2 Carbide

Advantages of Carbide

(a) Carbide holds up well at elevated temperatures.
(b) Carbide can cut hard materials well.
(c) Solid carbide tools absorb work piece vibration and reduce the amount of
(d) chatter generated during machining.
(e) When inserted cutters are used, the inserts can be easily changed or indexed, rather than replacing the whole tool.

Disadvantages of Carbide

(a) Carbide costs more than high speed steel.
(b) Carbide is more brittle than HSS and has a tendency to chip during interrupted cuts.
(c) Carbide is harder to re-sharpen and requires diamond grinding wheels