UNIVERSITI TEKNIKAL MALAYSIA MELAKA

SIMULATION OF SPROCKET BY USING DIFFERENT TOOL PATHS PROCESS IN CAD/CAM SOFTWARE

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

By

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirement for the Degree of Engineering Technology (Maintenance Technology) with Honour. The member of supervisory is as follow:

…………………………..

(Project Supervisor)

MR. AHMAD ZUL HUSNI BIN CHE MAMAT

ABSTRAK

Pemilihan laluan mata alat adalah salah satu langkah yang mesti diambil kira semasa proses simulasi di dalam perisian *CAD/CAM* dan proses fabrikasi produk dengan menggunakan mesin *Computer Numerical Control (CNC)*. Jika pemilihan laluan mata alat yang berlaku adalah salah, ia akan mendatangkan masalah kepada masa yang diambil untuk proses fabrikasi produk tersebut dengan mengggunakan mesin *Computer Numerical Control*. Tiga jenis laluan mata alat telah dipilih dalam projek ini iaitu *Zig-zag*, Satu arah dan Heliks dimana ia digunakan untuk menjalankan proses fabrikasi produk iaitu prototaip gegancu motor. Semasa proses simulasi dijalankan, perisian *CAD/CAM* yang akan digunakan di dalam projek ini ialah *CATIA V5*. Selepas itu, setiap kod yang terhasil daripada proses simulasi akan dipindahan kepada mesin *Computer Numerical Control (CNC)* untuk proses fabrikasi prototaip gegancu motor. Masa yang diambil daripada proses simulasi dan fabrikasi akan dianalisis. Selain itu, masa yang diambil daripada proses simulasi dan fabrikasi juga akan dibandingkan dimana proses pembelajaran untuk mengetahui tiga jenis laluan mata alat itu yang mana akan mengambil masa yang pantas untuk menghasilkan prototaip gegancu motor. Pemilihan laluan mata alat yang betul akan menjadi factor utama dalam menghasilkan prototaip gegancu motor tersebut. Beberapa faktor juga telah dibincangkan dan dikenalpasti. Keputusan yang dijangkakan untuk projek ini adalah, laluan mata alat jenis *Zig-zag* akan mengambil masa yang pantas untuk menghasilkan prototaip gegancu motor jika dibandingkan dengan laluan mata alan Satu arah dan Heliks. Akhir sekali, semua objektif di dalam projek ini akan dijangkakan tercapai dan berjaya.

ABSTRACT

Tool paths selection is one of the most important steps that must to be considered in the simulation process of CAD/CAM software and product fabrication process by using Computer Numerical Control (CNC). If the wrong selection of tool paths is happen, it will become a problem to the time taken of product fabrication process by using Computer Numerical Control (CNC) machine. Three types of different tool paths was been selected in this project which are Zig-zag, One way and Inward helical in order to perform the fabrication process of motorcycle sprocket prototype. The CAD/CAM software that will use in this project for the simulation process is CATIA V5. Then, the coding that has been generated from the simulation process will be transferred to the Computer Numerical Control (CNC) machine for the fabrication process of motorcycle sprocket prototype. The time taken from simulation and fabrication process to produce a motorcycle sprocket prototype will be analysed. Besides that, the time taken from the simulation and fabrication process also will be compared in order to study which types of three different tool paths get the fastest time taken to produce a motorcycle sprocket prototype. The correct selection of tool paths will be a factor to produce a motorcycle sprocket prototype. There are a few factors that discussed and determined. The expected result for this project is the Zig-zag tool paths will perform the fastest time taken to produce the motorcycle sprocket prototype compared to the One way and Helical tool paths. Lastly, all the objective in this project will be expected as accomplished and succeeded.

DEDICATION

Dedicated to my father NOR ZAMRI BIN RASHID and my mother ZAMZILAWATI BINTI MOD ROS. To my supervisor MR AHMAD ZUL HUSNI BIN CHE MAMAT, all lecturers and friends of their help and motivate to me.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
CATIA	Computer Aided Three-dimensional Interactive Application
CNC	Computer Numerical Control
H/W	IT Hardware
ID	Identification
ISO	International Standard Organization
IT	Information Technology
mm	Millimetre
mm_mn	Millimetre per minute
NC	Numerical Control
PMCs	Plant Material Centres
S/W	Specialised Software

CHAPTER 1

INTRODUCTION

1.1 Background

In the producing and processing finished products, there are many methods that can be used. There are 4 general different processes which is Casting, Moulding, Forming, and Machining. Focusing to the machining process, that is including Milling, Turning, Drilling, Reaming, Tapping and Sawing. All of these processes are need to be highly considered to find the best process and produce a high and good quality product.

Milling operation is a machining process that is used to remove the material from the work piece in a direction of an angle with the axis of the tool. It used a cutter that rotates to remove the material from the work piece. From the milling machine, it can performed many of operations and function which is starting from the small until to large objects. This process is commonly used in industry and machine shops today for machining parts to design a shape of products no matter it is in complicated design (Smith, 2016).

Nowadays, the integration of milling into turning environments and turning into milling environments, is begin with live tooling for lathes and the occasional used of mills for turning operations that lead to a new class of machines tools which is known as a multi-tasking machine that is multi-purpose machine. The machine can perform milling and turning process for a material in an operation. Then, after the coming of Computer Numerical Control (CNC), milling machine has flourish to high quality machining which is with tool magazines or carousels, automatic tool changers, coolant systems and enclosures. In the turning processes and milling processes are combined together in this machine.

Other than that, milling also is a cutting process that to removed or cutting away the wasted material. The machine must be running in a high speed to rotates the sharpen teeth of cutting tools for removing the unwanted material. When the work piece is place below the cutting tool, the material will be cutting from the work piece and create a desired shape or design. To produce parts or products which are not axially symmetric and has many features on it like holes, slots and even three dimensional contours the milling machine can do the operations. The milling cutters will be cutting the work piece surfaces on each side for the periphery milling. There are two types of milling machines which are vertical and horizontal milling machine (Steve, n.d).

Vertical mill has a spindle axis that is arranged to make a rotation by stay at the same axis and get two further categories which are bed and turret mill. For bed mill, it has spindle that moved parallel to the axis and a perpendicular moved for the table to the axis. Then, for turret mill the spindle is working to remove the unwanted material which is the table is moving perpendicularly and parallel to its. Horizontal milling also has a same cutting tool but the cutting tools are placed on the horizontal axis. The rotary tables will help in milling operation in a various angle that is getting on a lot of horizontal mills. It's also called universal tables and from the vertical cutting tool mill can be also used in horizontal mill (Steve, n.d).

In the industry, a geometrical complexity, difficulty and custom made in machining of motorcycle sprocket has been always challenging. Now days, many of industries use CNC machines to design a turbo machinery or custom made components. Furthermore, to design the components it may use many of difference modelling and simulation engineering drawing software like AutoCAD, MasterCAM, CATIA V5, Autodesk Inventor, Pro-manufacture and Unigraphics NX. This software will generate the Numerical Control (NC) code to perform the simulation and the code will be transfer to the CNC machine to fabricate the prototype of motorcycle sprocket. Simulation and actual process it will be a major concern to know the effectiveness of cutting time to produce the sprocket and the tool movements that can be determine in term of tool paths (Dubovska et al., 2014).

1.2   Problem statement

Machining process of producing motorcycle sprocket will take a long time to complete if improper selection of tool paths is made (Australian Manufacturing Technology, 2011). The suitable selection of tool paths in the advanced machining process for producing motorcycle sprocket is very important. Furthermore, with the improper selection of tool paths during the advanced machining process, this situation affects the rate of production time (Australian Manufacturing Technology, 2011).

Besides that, the tasks of time minimization of various types of cutting techniques are formalized which are three types of different tool paths will be selected (Petunin, 2016). The possible ways to fabricate the motorcycle sprocket are identified and will simulate the fastest way between three various types of the tool paths to reduce machining time and produced quality product.

1.3   Objective

The several purposes of the studies about to design and simulate the motorcycle sprocket with three different tool paths machining processes by using CATIA V5 software and fabricate the prototype using Computer Numerical Control (CNC) machine to compare the time taken between simulation and actual process below:

a) Design the part of sprocket and perform simulation for several different tool paths of machining process on the sprocket using CATIA V5.
b) Fabricate the sprocket by using 3-axis CNC machine and compare the time taken from the simulation and actual process between the different tool paths.

c) Determine the fastest time of tool paths for the actual machining process.

1.4   Scopes of the project

Motorcycle sprocket is a part which is order from the customer by following their own specification. Motorcycle sprocket has main function is to transmit power and motion to the motorcycle for make a movement. In this case, motorcycle sprocket will be normally used for the motorcycle performance which is in race competition. Firstly, the prototype of motorcycle sprocket will be design by using the CAD: Computer Aided Design which is CATIA V5. Then, after the design is completed, the simulation of advanced machining processes for the prototype will be performed and the coding will be generated by using the CATIA V5.

In this case, there are three different tool paths operation will be selected which is to perform the simulation of the motorcycle sprocket prototype. There are three tool paths operation that will be performed which are Zig-zag, One Way and Helical operation. Besides that, the two CAD software were selected in order to compare which software is more accurate for command reading in the system and less time is taken to produce the motorcycle sprocket prototype.

The coding which is perform from the CATIA V5 simulation will be transferred the Computer Numerical Control (CNC) machine to fabricate the motorcycle sprocket prototype. Other than that, there is several of parameter that must be focused which is the fixed and variable parameters. The selected of the prototype material and the type of cutting tool will be the fixed parameter while the different types of tool paths operation will be the variable parameter in the project. Therefore, the time taken from the CAD software simulation and the time taken to fabricate the motorcycle sprocket prototype will be collected and to be analysed.

CHAPTER 2
LITERATURE REVIEW

2.1   Sprocket

Sprocket is a wheel which is have a sharpened toothed around it that is designed to connected with something that will be pulled over the wheel when the wheel is being rotates. These sprockets are similarly looked like a gear, but not like gears which are they are not designed to be destructed with other gears. These basic designs for the simple mechanical component have been used around the world for long time ago and will be used in many of applications starting from in advancing the film for disposable camera to the powering professional class bicycles. One of the famous settings for a sprocket is used in a bicycle, where the sprocket is connected to the chain to transform a movement for the bicycles when the riders make a stroke into the rotation of the wheels. The size of the sprocket also can be adjusted to make change of gearing of the bicycles for the different cycling situation or operation. Other than that, the sprocket also is used in motorcycles manufactured and some other types of motorized vehicles. Based on (Williams et al., 2014) these motorcycles sprocket is also important mechanical component to transmit power and motion to the motorcycles for make a movement. Furthermore, for motorcycles sprocket it has two types of sprockets which is coming in pair for rear and front sprocket. The chain will get a connection to the rear and front sprocket which is front sprocket will drives the rear sprocket to make an operation (Ambole, n.d).

According to (Rexnord, n. d.) sprocket can be applied to any wheel which has a chain connecting through it. Furthermore, sprockets also came in many various materials and styles but it depend on the application for the service requirements. The most applications which are using sprockets, fabricated steel sprockets are much recommended to be the best combination performance, price and availability to use. The fabricated steel sprocket can be found for every chain tooth combination. From

the table 2.1 below will showed the classification of sprocket by general form (Williams et al., 2014).

S/N	Sprocket style	Use	Advantages
	Cast Arm Body	Used where larger sizes are required.	Reduction of weight
	Cast Split (Arm or Plate) Body	To prevent bearings or other connected equipment being disturbed.	Reduces installation and downtime.
	Cast Plate Body	Required for the smaller sizes where the use of arms is impractical and on larger sizes when the chain pull exceeds the strength of the arm body sprockets.	Transmits high torque
	Fabricated steel sprockets	Use of arms is impractical and on larger sizes when the chain's pull exceeds the strength of the arm body sprockets.	Transmits high torque and easy to manufacture
	Shear Pin like flanged rim	They are used in special applications where jamming or overloading is prevalent	Protecting machinery and equipment from damage.
	Special Sprockets	Use particularly in the products and fertilizer industries.	

Table 2.1: Sprocket Styles (Williams et al., 2014)

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2.1.1 Mild Steel Sprocket Material

The motorcycle sprocket is made in many types of material which is for example is mild steel material. The analysis for the mild steel material has been done which known as steel is a traditional material for a sprocket chain. Furthermore, steel also is easy to get and the machinery for machining process of steel also is easy to get. The market price for steel is cheap compare to the other materials. With this advantages that have at mild steel, this is why about 99% of the sprocket chain is made from mild steel. Steel also have its own characteristics which is stiff but dense (heavy). Other than that, steel have a good ratings in terms of both yield strength and ultimate strength, especially if the material is carefully alloyed and processed. Besides that, steel also against the fatigue failure which is very useful for the sprocket manufacture even the sprocket chain is under load for example the steel need to flexing but it will not lead to a critical failure (Ambole, 2016).

2.1.2 Carbon Fibre Sprocket Material

Carbon fibres have provided the most basics for the development of Plant Materials Center (PMCs) as an advanced structural for engineering materials. In general term of materials, low modulus fibres have lower specific gravities, lower cost, higher tensile strength to failure than high modulus fibres, higher tensile and compressive strength. The carbon fibres have many of advantages which their extremely high tensile strength to weight ratio and tensile modulus to weight ratios. Furthermore, carbon fibres also have high fatigue strengths (Ambole, 2016).

The low impact of resistance and high electric conductivity is the disadvantages that have in carbon fibre material which can cause shorting in the unprotected electrical machinery. Other than that, carbon fibre is high cost materials which are widely used in the aerospace and some applications of sporting goods. The applications are taking the advantages of the carbon