



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**DESIGN OF AUTOMATIC WORKPIECE CLAMP FOR BRIDGEPORT  
VERTICAL MILLING MACHINE**

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia  
Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering  
(Robotics & Automation) (Hons.)

By

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## **DECLARATION**

I hereby, declared this report entitled “Design of Automatic Workpiece Clamp for Bridgeport Vertical Milling Machine” is the results of my own research except as cited in references.

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## **APPROVAL**

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotics & Automation) (Hons.). The members of the supervisory committee are as follows:

.....

(Principal Supervisor) – Signature & Stamp

## **ABSTRACT**

This project report presents the work done on the design of an automatic workpiece clamp for Bridgeport Vertical Milling Machine. This machine is a type of milling machine that is used in machine shop at Block B of Faculty of Manufacturing Engineering, Universiti Teknikal Malaysia Melaka (UTeM). The machine is still using a conventional power screw workpiece clamp that is needed to use a lot of force by the operator to clamp the workpiece. If the clamping force is not enough, the workpiece can come out from the clamp and could cause injury to the operator and also can damage the machine. Furthermore, the workpiece can also be damaged during machining operation if the clamping force is not enough. The objectives of this project are to design an automatic workpiece clamp for Bridgeport Vertical Milling Machine and to develop soft prototype of the above designed automatic workpiece clamp. To achieve the objectives, a flow chart was developed as a guide line to be followed during the whole project. This project is focusing on automatic workpiece clamp that needs to be customize to suite with the Bridgeport Vertical Milling Machine. Several design ideas are generated and presented in this report. The listing of all parts need to be fabricated and the standard parts are also presented. This report also explained about the assembly design using explode view to make better understanding on how to assemble the automatic workpiece clamp. A good design was able to be produced that can be developed in future. SolidWorks software has been used as a design tool and also as simulation platform to animate the design. Finite Element Analysis (FEA) that are provided in the SolidWorks has been used to analyze the design to make sure that a good design is produced. Suggestion for further work is also included in this report.

## ABSTRAK

Laporan ini menjelaskan tentang reka bentuk pengapit bahan kerja automatik untuk Bridgeport 'milling machine'. Mesin ini merupakan salah satu jenis mesin 'milling' yang digunakan di Blok B Fakulti Kejuruteraan Pembuatan (FKP), Universiti Teknikal Malaysia Melaka (UTeM). Mesin ini masih menggunakan pengapit bahan kerja konvensional yang memerlukan penggunaan tenaga yang banyak daripada pengendali untuk mengapit bahan kerja. Jika daya apikan tidak mencukupi, bahan kerja mungkin akan terkeluar dari pengapit dan boleh menyebabkan kecederaan kepada pengendali dan juga boleh merosakkan mesin. Tujuan projek ini adalah untuk reka bentuk pengapit bahan kerja automatik untuk mesin 'milling' Bridgeport dan untuk membuat prototaip pengapit bahan kerja automatik yang telah direka. Bagi mencapai objektif, satu carta aliran telah dibuat sebagai garis panduan yang perlu diikuti semasa projek dijalankan. Projek ini memberi tumpuan kepada pengapit bahan kerja automatik yang perlu direka untuk disesuaikan kepada mesin 'milling' Bridgeport. Beberapa idea reka bentuk telah dihasilkan dan dibentangkan dalam laporan ini. Penyenaiaan semua bahagian yang perlu direka dan bahagian yang standard juga turut disertakan. Laporan ini juga menjelaskan reka bentuk pemasangan menggunakan pandangan ceraiian untuk memberi pemahaman yang lebih baik tentang cara-cara pemasangan pengapit bahan kerja automatik. Perisian 'SolidWorks' digunakan sebagai alat reka bentuk dan juga sebagai platform simulasi untuk menganimasi reka bentuk. Finite Element Analysis (FEA) yang disediakan di dalam 'SolidWorks' telah digunakan untuk menganalisis reka bentuk bagi memastikan reka bentuk yang baik telah dihasilkan. Cadangan untuk kajian selanjutnya juga disediakan dalam laporan ini.

## **DEDICATION**

*To my beloved family, friends and lecturers whose have guided and inspired me to complete this project successfully. Also, to my late mother Rahmah Hassan who always want me to succeed in life. This work is dedicated to them.*

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## LIST OF ABBREVIATIONS

AHP	-	Analytical Hierarchy Process
2D	-	Two Dimension
3D	-	Three Dimension
CAD	-	Computer Aided Design
CAE	-	Computer Aided Engineering
CAM	-	Computer Aided Manufacturing
CATIA	-	Computer Aided Three-dimensional Interactive Application
CNC	-	Computer Numerical Control
DOF	-	Degree of Freedom
FEA	-	Finite Element Analysis
FKP	-	Fakulti Kejuruteraan Pembuatan
FoS	-	Factor of Safety
FTMK	-	Fakulti Teknologi Maklumat dan Komunikasi
UTeM	-	Universiti Teknikal Malaysia Melaka



## LIST OF SYMBOLS

%	-	Percentage
°	-	Degree
cm	-	Centimeter
etc	-	Et Cetera
Kg	-	Kilo Gram
kW	-	Kilo Watt
mm	-	Milimeter
N	-	Newton
m	-	Meter
Pa	-	Pascals
kPa	-	Kilo Pascals

# **CHAPTER 1**

## **INTRODUCTION**

### **1.1 Background Of The Project**

Milling machines are very versatile. They are usually used to machine flat surfaces on square or rectangular parts, but can also produce many unique and irregular surfaces. They can also be used to drill, bore, produces slot, pockets and many other shapes. (me.ucr.edu. 2011). There are two types of milling machines which are conventional milling machine and CNC milling machine. In a conventional milling machine, most of the operation is done by human while in CNC milling machine, the tool is controlled by a code system that enables it to be operated with minimal supervision and with great deal of repeatability. But, the similarities of this two types of machine is that both of the machine uses the same type of clamping system. There are many parts and components of Bridgeport Vertical Milling Machine including a power screw workpiece clamp that is to be redesigned in this project. Workpiece clamp is a component that holds the workpiece during operation such as milling, drilling, and boring. The clamping should be strong enough to withstand forces developed during operation and should not dent or damage the workpiece. Basically, this project is to automate workpiece clamp to replace the conventional power screw clamp of the Bridgeport Vertical Milling Machine. Figure 1.1 shows Bridgeport Vertical Milling Machine in Machine Shop at Block B of Faculty of Manufacturing Engineering (FKP), UTeM.



Figure 1.1: Bridgeport Vertical Milling Machine at Machine Shop at Block B of FKP

## 1.2 Problem Statement

The Bridgeport Vertical Milling Machine that is used in machine shop at Block B of FKP is still using a conventional power screw workpiece clamp as shown in Figure 1.2. The problem is that the operator need to use a lot of energy to clamp or release the workpiece. Besides that, everybody have a different amount of energy to use the conventional power screw thus the clamp force is not consistent every time it is being tighten. If the clamping force is not enough, the workpiece may come out from the clamp and could cause injury to the operator and nearby people and also could damage the machine. An initiative to design an automatic workpiece clamp is taken to solve this problem.

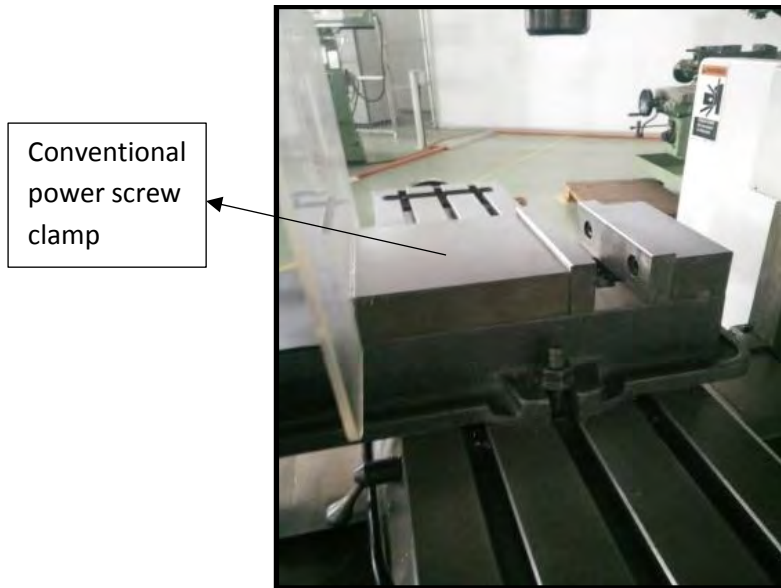


Figure 1.2: Conventional Power Screw workpiece clamp for Bridgeport Vertical Milling Machine

### 1.3 Objective

- i. To design an automatic workpiece clamp for Bridgeport Vertical Milling Machine.
- ii. To develop soft prototype of the above designed automatic workpiece clamp.

### 1.4 Scope

- i. To design an automatic workpiece clamp that is to be focused on a rectangular shape workpiece because it is the common shape of workpiece to be processed by milling machine. The maximum dimensions of workpiece to be clamped are as follows:  
Length: 15 cm  
Width: 11 cm  
Thickness: 5 cm
- ii. Workpiece material: Steel, Aluminium, etc.

- iii. To develop soft prototype of the designed workpiece clamp using a suitable Computer Aided Design (CAD) software.

## **CHAPTER 2**

### **LITERATURE REVIEW**

This chapter provides literature review in which the sources and information are obtained from the internet, journals, articles and other sources. This chapter will discuss and explain about the Bridgeport Vertical Milling Machine, clamping system of the Bridgeport Vertical Milling Machine, existing clamping system, locating and clamping principles and factors in selecting clamp to generate any design ideas. Several types of Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) software are to be reviewed for selection of the most suitable one for this project.

#### **2.1 Bridgeport Vertical Milling Machine**

Bridgeport is a brand of milling machines and machining centers, which are machine tools used in the machining industries. The brand was produced by Bridgeport Machines, Inc. from 1938 until 2004, when it was acquired by Hardinge, Inc., its current owner. Hardinge is a multinational corporation whose machine tool brands include Hardinge, Bridgeport, Kellenberger, Hauser, Tripet, and Tschudin. (medlibrary.org, 2016). This machine was manufactured by Enrique Holke, S.L in 2002 and was made in United State of America.

Milling machines are an important industrial tool for machining solid materials like wood and metal. They can perform a vast number of functions ordinarily done by hand, thus speeding up and facilitating a faster and more efficient workflow. Bridgeport vertical milling machine is a conventional milling machine which need to be operated manually. This machine can do most of the operation like a CNC milling machine but the production time is much slower due to many factors like positioning and clamping the workpiece are done manually.

Bridgeport Vertical Milling machine as shown in Figure 2.1 has 4kW power. Size of this machine is 3000 x 1970 x 2250 (mm) and the weight is 1450 Kg. The maximum spindle speed of this machine is 4200 rpm.



Figure 2.1: Bridgeport Vertical Milling Machine

## 2.2 Workpiece Clamp of Bridgeport Vertical Milling Machine.

A clamp is fastening device used to hold or secure objects tightly together to prevent movement or separation through the application of inward pressure. Once workpiece is located, it is necessary to press it against locating surfaces and hold it there against the force acting upon it. (V. Paramasivam et. al., 2010). This action is refer as clamping process and the mechanisms used for this action are known as workpiece clamps. A vise is used in Bridgeport Vertical Milling machine to clamp and hold the workpiece again the force acting upon it during milling operation. It is a type of conventional power screw clamp that need human energy to drive the screw to tighten the vise. (M. Amirul, 2014). Figure 2.2 shows the vise of Bridgeport Vertical Milling Machine.

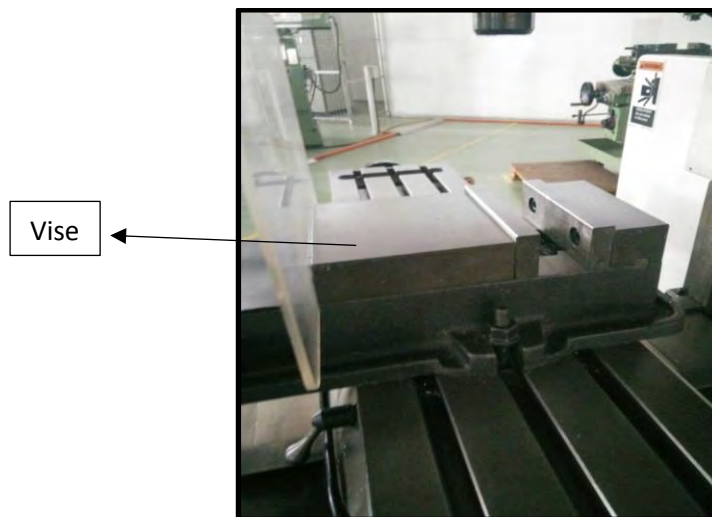


Figure 2.2: Vise of Bridgeport Vertical Milling Machine