



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Development of Vertical Milling Machine Educational Kit Using Various 3D Printing Methods to Assess Rapid Prototyping Process Capability

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

by

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This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor Degree of Manufacturing Engineering Technology (Product Design) with Honours. The member of the supervisory is as follow:

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MR. MOHD RAZALI BIN MD YUNOS

(Project Supervisor)

ABSTRACT

The purpose of this project is to develop a prototype of vertical milling machine educational kit. Vertical milling machine is an equipment used in machining process of using rotary cutters to remove material from a workpiece by advancing in a direction at an angle with the axis of the tool. In this project, vertical milling machine will be built by using various 3D printing methods to assess rapid prototyping process capability. Rapid Prototyping technologies have a various types that commonly used in industry. In rapid prototyping, there are many kinds of material used to produce the product or in details; to produce prototype. The methods that used to build this machine by using three methods only such as Stereolithography (SLA), Selective Laser Sintering (SLS), and Fused Deposition Modelling (FDM). The selection methods for finished part are important in order to choose the best material that should be used for 3D printing in order to get a high quality prototype and to know the capability of the 3D printing methods. The selection methods that should be known and consider such as dimensional accuracy and surface finish of each parts. Based on the study of selection material was found that it necessary in order to choose the best material to get the strong product and not fragile. Finally, the prototype of vertical milling machine are successfully being produced using the best methods and it can be function to rotate the movement of X, Y and Z axis. Then, the process of evaluating capability of the 3D printing methods has been achieved by using Surface Roughness Tester Machine and vernier caliper.

ABSTRAK

Tujuan projek ini adalah untuk membangunkan prototaip “vertical milling machine educational kit”. Mesin pengilangan menegak adalah peralatan yang digunakan dalam proses pemesinan menggunakan pemotong berputar untuk mengeluarkan bahan dari bahan kerja dengan memajukan arah pada sudut dengan paksi alat. Dalam projek ini, mesin pengilangan menegak akan dibina dengan menggunakan pelbagai kaedah percetakan 3D untuk menilai keupayaan proses prototaip pantas. Teknologi prototaip pantas mempunyai pelbagai jenis yang biasa digunakan dalam industri. Dalam prototaip pantas, terdapat pelbagai jenis bahan yang digunakan untuk menghasilkan produk atau secara terperinci; untuk menghasilkan prototaip. Kaedah yang digunakan untuk membina mesin ini dengan menggunakan tiga kaedah sahaja seperti Stereolithography (SLA), Selective Laser Sintering (SLS), dan Fused Deposition Modelling (FDM). Kaedah pemilihan yang perlu diketahui dan dipertimbangkan seperti ketepatan dimensi dan kemasan permukaan setiap bahagian. Berdasarkan kajian bahan pemilihan didapati bahawa perlu untuk memilih bahan terbaik untuk mendapatkan produk yang kuat dan tidak rapuh. Akhir sekali, prototaip mesin pengilangan menegak berjaya dihasilkan menggunakan kaedah terbaik dan boleh berfungsi untuk memutar pergerakan X, Y dan Z axis. Kemudian, proses menilai keupayaan kaedah percetakan 3D telah dicapai dengan menggunakan “Surface Roughness Tester Machine” dan “vernier caliper”.

DEDICATION

To my beloved parents,

MR. MOHD NOOR BIN ABDULLAH

MRS. UMI HAFIZAH BINTI HJ. MASRI

To my respectful supervisor and co-supervisor,

MR. MOHD RAZALI BIN MD YUNOS

MR. MOHD NAZRI BIN AHMAD

To my all dear friends

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AM	-	Additive Manufacturing
ABS	-	Acrylonitrile Butadiene Styrene
CLIP	-	Continuous Liquid Interface Production
CAD	-	Computer Aided Design
FDM	-	Fused Deposition Modelling
LOM	-	Laminated Object Manufacturing
PLA	-	Polylactic acid
RP	-	Rapid Prototyping
R _a	-	Arithmetical mean roughness
SLA	-	Stereolithography
SLS	-	Selective Laser Sintering
STL	-	Stereolithography
3D	-	Three Dimensional
3DP	-	Three Dimensional Printer

CHAPTER 1

INTRODUCTION

Basically, this chapter will give a brief explanation about this project, starting with the background of the project title “Development of Vertical Milling Machine Educational Kit Using Various 3D Printing Methods to Assess Rapid Prototyping Process Capability”. This chapter will also discuss about the problem statement, the objectives, and the scope of this project.

1.1 Background

Rapid prototyping (RP) is a group of techniques used to fabricate a scale model of a physical parts or assembly using three-dimensional computer aided design (CAD) data. Construction of the part or assembly is usually done using additive manufacturing technology. Besides, Rapid prototyping technologies allow the manufacture of prototypes the product that can be used as concept or functional of the models. So that’s, it means the prototypes will be support for new products development in future. Rapid Manufacturing is also an additive process that creates directly the actual product by 3D printing without any production tools needed.

Other than that, 3D printings are also known as an additive manufacturing, refers to various processes used to synthesize a three-dimensional object which successive layers of material are formed under computer control to create an object. The size of the objects can be of almost any shape or geometry and are produced using digital model

data from a 3D model such as an Additive Manufacturing File. There are large number of additive processes are now available in the market.

The main differences between processes are in the way layers are deposited to create parts and in the materials that are used. Some methods melt or soften the material to produce the layers, such as Selective Laser Sintering (SLS), Fused Deposition Modelling (FDM), while others cure liquid materials using different technologies, such as Stereolithography (SLA). With Laminated Object Manufacturing (LOM), thin layers are cut to shape and joined together. But, it is a common thing that each of the method they has its own advantages and disadvantages. With development and mature of 3D printing technology, it has been widely used in various fields. With the great wealth of life, the product wants to occupied more market share, so it is necessary to meet the needs of users as much as possible. The main considerations in choosing a machine are generally speed, costs of the 3D printer, printed prototype, choice and cost of the materials, and colour capabilities.

So, this project is about to design and produce vertical milling machine educational kit using 3D printing methods. The selection methods before produce the milling machine must be selected with a suitable materials. Then, this project will continue with capabilities evaluation of 3D printing methods for each part of vertical milling machine.

1.2 Problem Statement

Rapid Prototyping technologies has a various types that commonly used in industry such as Selective Laser Sintering (SLS), Stereolithography (SLA), Fused Deposition Modelling (FDM), Laminated Object Manufacturing (LOM) and Three Dimensional Printer (3DP). It also has different forms of Rapid Prototyping for different purposes. Each one has aspects that make it beneficial, as well as weak point. The wrong methods will give impact to the product such as fragile, poor surface quality, internal structure of product is missing or broken and so on. So, the main problem to focus in this project is about to analyze the best methods of rapid prototyping technologies for each