UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF CASING AND VENTILATION SYSTEM IN 3D PRINTER, PRUSA I3 BY USING INTEGRATED APPROACH

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

by

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FACULTY OF ENGINEERING TECHNOLOGY

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TAJUK: **Development of Casing and Ventilation System in 3D Printer, Prusa i3 by using Integrated Approach**

SESI PENGAJIAN: **2017/2018** **Semester 1**

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APPROVAL

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

……

(Mr. Mohd Nazri Bin Ahmad)

ABSTRAK

Projek ini membentangkan mengenai penghasilan selongsong dan juga system pengudaraan dalam pencetak 3D, Prusa i3 dengan menggunakan kaedah bersepadu. Projek ini lebih tertumpu kepada pembuatan terpantas (RP) dengan 'Fused Deposition Modelling' (FDM) khusus untuk Prusa i3. Tujuan utama projek ini adalah untuk mengawal suhu pada sekitar produk yang dicetak. Hal ini kerana, suhu yang tinggi boleh menyebabkan ledingan terutama pada akhir bahagian yang dicetak. Oleh itu,pemasangan alat pengesan suhu pada selongsong diletak bagi memudahkan suhu yang berlebihan dikesan pada tempat pencetak. Seterusnya, memberi tanda kepada kipas ekzos untuk dihidupkan. Selain daripada itu, wasap toksik yang dihasilkan oleh filament seperti PLA and ABS semasa penyemperitan filamen boleh menyebabkan masalah kesihatan yang serius jika tidak dirawat. Bagi menyelesaikan masalah ini, penghasilan sistem pengudaraan daripada kombinasi kipas ekzos dan penapis carbon digunakan untuk menyerap dan membuang bahan cemar dan kekotoran di udara. Penghasilan selongsong ini sangat berguna untuk mengelakkan bau yang tidak menyenangkan dari mencemarkan alam sekitar. Bagi proses penghasilan selongsong, terdapat beberapa langkah yang perlu di ambil agar rekabentuk selongsong yang baik dapat dihasilkan dan kaedah Pugh's dipilih bagi menentukan konsep rekabentuk yang sesuai dengan kehendak pengguna. Konsep rekabentuk yang mendapat skor yang tertinggi dilukis secara teliti dengan menggunakan *Solidworks*. Dengan ini, proses fabrikasi dimulakan bagi menghasilkan selongsong dan sistem pengudaraan. Produk yang terhasil dengan pengunaan selongsong ini lebih baik dari sebelumnya. Hal ini dapat disimpulkan bahawa penghasilan selongsong ini dapat menambahbaikan produk yang dicetak.

ABSTRACT

This project entitled Development of Casing and Ventilation System in 3D Printer, Prusa i3 by using Integrated Approach is focus on the Rapid Prototyping (RP) technologies with Fused Deposition Modelling (FDM) specifically for Prusa i3. The main purpose of this project is to reduce the temperature around the printed part. The higher temperature may causes warping especially at the end of the printed part. By installed the temperature sensor at the casing, it may detected the excessive temperature of the print bed. Thus, give the sign to the exhaust fan to switch on. In addition, the toxic fumes produced by filament such as PLA and ABS during filament extrusion can cause serious health issue if untreated. In order to solve this problem, the ventilation system which is combination of exhaust fan and carbon filter is used to absorb and remove contaminants and impurities in the air. The casing is very useful to avoid unpleasant odour from contaminate the environment. For the casing development, there are several steps that should be taken in order to design a well casing. The Pugh's method is used to determine the design concepts that suit the needs of the user. All the detailed design of the design concept selected need to develop using Solidworks. Then, the fabrication process was initiated to produce casing and ventilation systems. After testing, the observation has been done and found that the printed part result is better after using this casing. So that, it can be concluded that the development of this casing can improve the printed product.

DEDICATION

To my beloved parents and siblings

ACKNOWLEGEMENT

First of all, I am very thankful to Allah S.W.T the Most Gracious, Most Merciful because of the strength and opportunity that He giving me in order to completing this final year project.

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Last but not least, I would like to state my appreciation to staff – FTK, my friends and colleagues for supporting me in this project. Also, thanks to anyone that help me whether in direct or indirect.

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LIST ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

3D printing	-	Three Dimensional printing
ABS	-	Acrylonitrile Butadiene Styrene
AM	-	Additive manufacturing
CAD	-	Computer-aided design
DMLS	-	Direct Metal Laser Sintering
FDM	-	Fused Deposition Modelling
FFF	-	Fused Filament Fabrication
HEPA	-	High Efficiency Particulate Air
HVAC	-	Heating, ventilation and air conditioning
ICs	-	Integrated Circuits
LOM	-	Laminated Object Manufacturing
NTC	-	Negative Temperature Coefficient
PLA	-	Polylactic Acid
RTD	-	Resistance Temperature Detector
SLA	-	Stereolithography
SLM	-	Selective Laser Melting
SLS	-	Selective Laser Sintering

UV light	-	Ultraviolet light
VOCs	-	Volatile Organic Carbon
mm	-	Milimeter

CHAPTER 1
INTRODUCTION

1.0 Introduction

The first chapter in this report explains about the background of this project, problem statement, objectives, work scope and project planning as well as the expected result from this project.

1.1 Background

Currently, 3D printing is one of the modern technology used to create any physical product from prototypes and simple parts to highly technical final products such as airplane parts, eco-friendly buildings, life-saving medical implants and even artificial organs using layers of human cells. This technology is very useful.

By heating the nozzle, the material melted and moved in both horizontal and vertical directions by a numerically controlled mechanism. After extrusion from the nozzle, the extruding melted material produced the object in form layers and turn immediately to the material hardens. Basically, this technology is mostly used with two types of material for plastic filament which is Acrylonitrile Butadiene Styrene (ABS) and Polylactic acid (PLA).

The purpose of this project is to develop a casing and the system of ventilation that can help to decrease the temperature around the printed parts especially at the end of the parts from getting warped. On the other hand, casing is needed due to types of

3D printing is open source and to make sure that the condition of the 3d printing are always well. Besides that, it is important to avoid the fumes of the material from being exposed to the external environment.

1.2 Problem Statement

3D printing or additive manufacturing (AM) is a process of creating physical objects from digital models by layer-wise material deposition or hardening. For 3D printer, Prusa i3 is the newest design of upgradable with many improvements and all parts of this 3D printer are open source. However, the main problem on this project is to improve the end part of the products from warped due to inconsistence of temperature.

Generally, the material used in this 3D printer which is Fused Deposition Modelling (FDM) is ABS and PLA. Both materials released toxic fumes known as VOCs (Volatile Organic Carbon). Since 3D printers are projected to enter people's daily lives, environmental and health risk posed by these filaments during the printing process are now drawing attentions from researchers. Actually, not all VOCs are toxic, but ABS released unpleasant odour during filament extrusion and it would be a serious health issue if untreated. In addition, it may cause eye, skin, and respiratory track irritation, and if overexposed, it also could cause nausea and headache.

1.3 Objectives

The objective of this project is to improve the condition of printed parts by using integrated approach. This objective can be achieved by following specific goals. The objectives of this project are:

i. To design a new casing and fume extraction for 3D printer, Prusa i3.
ii. To fabricate casing and fume extraction for 3D printer, Prusa i3.
iii. To improve printed part due to inconsistence of temperature.

1.4 Work Scopes

The scopes of this project are specifically aiming to improve the 3D printing for Prusa i3 in terms of physical and quality of the printed parts. This project focuses on the design of the casing and also the ventilation system used in the casing. The design concept of the casing should remain the temperature of the inside casing.

1.5 Project Planning

First of all, the title of this project is defined to ease the writing of this report followed by the search of project sources which include the primary and secondary source. The primary sources are integrated approach which is from the problem that faced by the previous user.

Besides that, it is regards from the problem statements, objectives, and scopes of the project. While secondary sources come from journals, articles, newspapers as well as trusted sources from the internet. Last but not least, the related case studies regarding this project will be included in the literature review.

To ensure this project proceed well and smoothly, the plans that will be implemented during the final year project 1 and 2 have been set up well by using the Gantt chart. The Gantt chart can be referred at Appendix A. This project divided into two phase. For phase 1 which is for final year project 1 (PSM 1), the focused more on the findings of this project and to find out the methodology used in this project. In phase 2 (PSM 2), it will came out with the outcomes and result of the project.

1.6 Expected Results

This section explains about the expectation result for this project. At the end of this project, the ventilation system can function well to control the surrounding temperature to reduce warping on the printed product. So, it will improve the end part

of the printed part from warped due to inconsistency of temperature. Besides that, it will control the air exchange and guarantee a hygienically indoor air quality.

Moreover, the benefits of develop the casing is to control the environmental friendly because it is able to prevent toxic fumes from came out and contaminate the surrounding air. The main thing is to complete product design as well as a complete functioning prototype to be developed same as the planning.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

Meanwhile in this chapter will explain deeply about the theory needed to acquire design of casing and ventilation system. Generally, this chapter contains introduction to 3D printing, introduction to Prusa i3, the casing for Prusa i3, the ventilation system used in Prusa i3 and the material used in 3D printing. This chapter enlighten the tools that will be used for this research, which is the integrated approach.

2.1 3D Printing

Text In the manufacturing sector, forms of 3D printing have been in use for more than a decade. It is known as an "additive manufacturing process" where "a three-dimensional object is created by laying down successive layers of material that adhere to one another, creating a three-dimensional output" (Kurt and Colegrove, 2012).

The 3D printer starts the process at the bottom of the design and builds up successive layers of material until the object is finished. Each of these layers can be seen as a thinly sliced horizontal cross-section of the eventual object as shown in Figure 2.1. It has a strong bonding between the filament when printing in x or y direction. Additionally, it is essential in the formation of the 3D object.

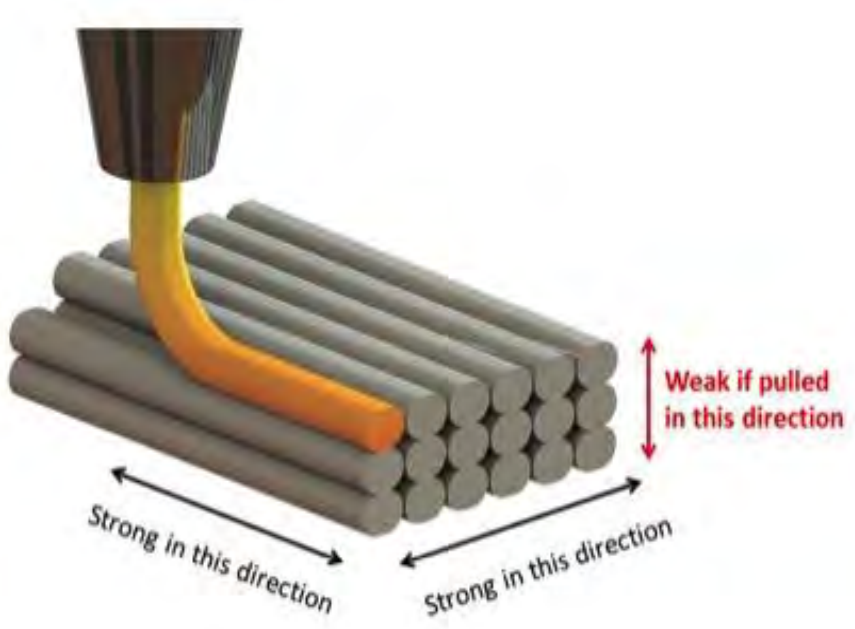

Figure 2.1: The process of 3D printing by builds up layering.
(Source: <http://blog.capinc.com/2014/12/design-for-3d-printing-success/> 12/5/2017)

Furthermore, 3D printing can produce almost anything from toys, accessories, sneakers, guns, wheelchairs and even organs like hearts. It is one of the growing industries today. This technology can be used to create everything from prototypes and simple parts to highly technical final products.

In the past, 3D printing was very expensive and not feasible for the general market. However, the development of desktop 3D printers has made the technology more accessible allowing 3D printers to find their way to a more affordable market because of costs drastically dropped. Before 3D printers existed, creating a prototype was time-consuming and expensive, requiring skilled craftsmen and specific machinery.

First developed in the 1980s, 3D printing or additive manufacturing refers to several different methods of creating three-dimensional objects from computer-aided design (CAD) files. Engineers, designers and product development teams use 3D printing to quickly and inexpensively create prototypes that can be tested for form and function. This allows them to improve an object's design before it is manufactured on a large scale (Elizabeth Palermo, October 9, 2013)