



**Faculty of Mechanical and Manufacturing Engineering
Technology**

**ANALYSIS OF THE FLEXIBLE PRINTED CIRCUIT BOARD INKJET
LABELLING READABILITY VIA 3D LASER MICROSCOPY:
CASE STUDY AT MFS TECHNOLOGY SDN BHD**

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Bachelor of Manufacturing Engineering Technology (Process and Technology)

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**FLEXIBLE PRINTED CIRCUIT BOARD INKJET LABELLING
READABILITY VIA 3D LASER MICROSCOPY AT MFS TECHNOLOGY SDN
BHD**

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in fulfillment of the requirements for the degree of Bachelor of Manufacturing
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ABSTRAK

Teknologi 'inkjet' telah menembusi besar ke dalam domain perindustrian. Malah, 'inkjet' telah menjadi teknologi matang untuk aplikasi grafik walaupun dalam pencetakan berfungsi seperti elektronik bercetak. Ia adalah dengan mendorong titisan dakwat ke atas kertas, plastik atau 'substrat' lain. Abjad boleh dicetak di papan litar bercetak dengan beberapa skala. Tetapi masalahnya, kaedah sebelumnya untuk menilai kualiti abjad hanya diukur secara kualitatif yang tidak berkesan. Sebagai contoh, aspek mengikuti skala yang diperlukan. Tujuan utama projek ini adalah usaha untuk menyiasat kualiti pembacaan abjad pada papan litar bercetak secara kuantitatif dengan data berangka. Oleh itu, projek ini akan membantu menggantikan kaedah terdahulu kepada kaedah yang lebih jelas dan membantu yang dapat menjustifikasikan kualiti produk. Ia boleh dilihat dengan angka yang mewakili purata, sisihan piawai dan corak graf untuk membuktikan kebolehterimaan kualiti terhadap abjad pada papan litar bercetak. Ia boleh dibandingkan dan dibuktikan dengan data sebenar. Data yang termasuk ketinggian dan lebar abjad dikaji di bawah perisian mikroskop dan Measure-X. Untuk kajian selanjutnya, lebih banyak abjad akan diperiksa dan analisis SEM dilakukan. Dari kajian ini, ia akan membantu industri pengeluaran yang ingin melihat kebolehbacaan dan kualiti abjad pada papan litar bercetak. Penyimpangan piawai huruf lurus adalah lebih kecil daripada huruf melengkung.

ABSTRACT

Inkjet technology has made large inroads into the industrial domain. In fact, inkjet has become a mature technology for graphical applications even in functional printing like printed electronics. It is by propel the droplets of ink onto paper, plastic or other substrates. The alphabet can be print out on the printed circuit board with several of scales. But the problem is, the previous method to evaluate the quality of alphabet only measured qualitatively which not effective. For example, aspect of following the required scale. The main purpose of this project is an effort to investigate the quality of readability of alphabet on the printed circuit board by quantitatively with numerical data. Thus, this project will help to alternate the previous method to more obvious and helpful method that can justify the quality of the product. It can be seen by numerical representing the average, standard deviation and pattern of graph to prove the acceptability of quality towards alphabet on printed circuit board. It can be compare and prove by actual data. The data that includes height and width of the alphabet is studied under microscope and Measure-X software. For further studies, more alphabets are inspected and SEM analysis is done. From this study, it will help the production industries that want to look through of the readability and quality of alphabet on printed circuit board. The standard deviation of straight alphabets is smaller than curvy alphabets.

DEDICATION

This humble effort specially dedicated to my dearest parents, family, lecturers and friends where love can never be forgotten for their motivation, guidance and encouragement upon completing this thesis.

Special dedicated to my family

HAYAT BIN AINI

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LIST OF SYMBOL

μ	-	Microns
$^{\circ}\text{C}$	-	Degree Celsius
dpi	-	dot per inch
mm	-	millimeter
MPa	-	mega pascal
cm	-	centimeter
pL	-	poiseuille
keV	-	kiloelectron volts

LIST OF ABBREVIATIONS

CAD	-	Computer Aided Design
CAM	-	Computer Aided Manufacturing
DOD	-	Drop-On-Demand
DOF	-	Depth-Of-Focus
EHD	-	Electro Hydrodynamic
ECHA	-	European Chemicals Agency
EVOH	-	Ethylene Vinyl Alcohol
GFRT	-	Glass Fiber Reinforced Thermoplastic
HDD	-	Hard Disk Drive
iSn	-	Immersion Tin
LED	-	Light Emitting Diode
Oh	-	Ohnesorage
OPEFB	-	Oil Palm Empty Fruit Bunch
OSP	-	Organic Solderability Preservative
PI	-	Polyimide
PCB	-	Printed Circuit Board
PF	-	Phenol-formaldehyde
PUF	-	Polyurethane Foams
PA66	-	Polyamide
PDMS	-	Poly(dimethyl)siloxane
RIP	-	Routing Information Protocol
SVHC	-	Substances of Very High Concern
SEM	-	Scanning Electron Microscope
UV	-	Ultra-violet

CHAPTER 1

INTRODUCTION

The first chapter will describe the outline and the purpose of this research. It will cover the introduction about the printing of inkjet, the industry that related to printing and few of the mechanisms. In this report also includes the background of the study, problem statement, objectives that are estimated to be accomplished and the limitation/constraint of the thesis that is going to be handled.

1.1 Background of Study

Currently, flexible electronics are commonly found in the broader industries that manufacture electronics. There are few dissimilar technologies used in the flexible circuit production processes. For instances, screen gravure, flexography, offset and printing of inkjet. This is as a result of the endless exploring for fresh manufacturing techniques that can be recognized in the electronic region, a developing concern in printing of inkjet shown in the last few years.

Small factories are now able to buy inkjet printers and started to be competitive in the market since the cost of inkjet technology including the printers, print head and ink

were essentially the same for everybody. In the past 8 years, inkjet printing has grown fast to become a dominant technique (Zapka, 2018).

Printing of inkjet is an additive and non-touching technology with a comparatively uncomplicated process phases regarding on preconditioning of the substrate material, ink removal and functionality of the ink layer. It is widely used in production interest and for home office printing. The simple character of the essential procedure printing of inkjet come from digital of dot-matrix techniques depend on jetting on ink droplets from a small-scale print head nozzle in a stated location on a substrate. There is no touching base between the print head and substrate in this type of printing. By this technique, an electronic component digital image parts is conveyed onto the substrate (Parmod and Sharma, 2017).

In recent years, new terms have emerged in the printing environment. Whereas for centuries only genuine graphical printing “graphic art is important”, now several terms and discipline such as “functional printing” “printed electronics” and “additive manufacturing” have emerged.

There are few techniques depends on dissimilar mechanisms used in the process of drop formation, which is piezoelectric, thermal, electrostatic and acoustic printing of inkjet. All the stated mechanisms are used in the printing of drop-on-demand (DOD) printing. Most DOD tools, though, practices either the mechanism of piezoelectric or thermal, but the early one is the main element in the context of flexible manufacturing of electronics (Parmod and Sharma, 2017).

Labelling in printed circuit board is essential because it will determine whether the robotic machine print the alphabet accurately based on the specification or not. Next, labelling also aid in the assembly process, as we know that on the printed circuit board,

there are several components will be placed on the surface. For examples, transistor and resistor. Previously, the method of placing the components is based on the operator itself which is by remembering.

1.2 Problem Statement

The evaluation of previous quality production of alphabet on printed circuit board is abstract and cannot see numerically. Thus, it makes the consumer of production tough to state about the quality. The easiest and practical way to make an evaluation is by measuring the recent production with the reference that accurate as a standard or benchmark. The alphabet itself has characteristics such as height, width, weight and condensation. The measured value of alphabet that investigated by microscope and software can be compared with the reference value. Other than that, element that affect the readability and quality of alphabet is, it is more sensitive to the interaction between the ink and the substrate. Thus, the alphabet produced also will give effects to the readability of alphabet (Zapka, 2018).

1.3 Objectives

The objectives of the thesis are:-

- i. To investigate the readability of alphabet that produced on the printed circuit board using inkjet printer.
- ii. To measure alphabet readability and quality of inkjet printer labeling.
- iii. To prepare scale of alphabet readability and quality of inkjet printer labeling starts from 0.5 mm until 1.0 mm.

1.4 Scope

This final year project is having constraint based on few aspects such as the material used. The consistency of quality and readability of the labelling on printed circuit board will be evaluated and determine based on few testing and experiment. The alphabet on the printed circuit board must be clear and obvious. For the testing, alphabet 'O' is chosen because it represents the less complexity among 25 other alphabets. It is less complex in terms of height and width measurement. After few discussions with my supervisor and also the engineer from MFS Technology, we discussed that the geometry and spherical shapes of 'O'. 'O' is called as "circle letters" that comprises almost entirely of circle. Based on the chosen alphabets, the height and width of 'O' is measured by taking few samples. The sample of 'O' is taken from various scales that start from 0.5 mm until 1.0 mm. The material is kept constant for the entire sample, which is the material used is PI Stiffener (polyimide). The profile use is fine. Other than fine, the company also has ultra-fine and standard type of profile. The differences between these profiles, it will determine the concentration of the alphabet, how the clarity that can be seen by naked eyes. Ultra-fine is the best type of profile while standard is the poor one. As fine is the intermediate profile, thus we choose it to make it as reference and benchmarks of how good the inkjet printer machine will operate. Abundant of samples 'O' will be collected and will be evaluate statistically as the justification of readability and quality that can be compared.

Other than 'O', other alphabets are chosen to be compared and to analyse between 2 categories of alphabets. Added alphabets are 'S' including previous 'O' to represent curvy alphabets. To compare, alphabets 'M' and 'E' are added in the collection of data represent as straight and sharp edges alphabets.

1.5 Report Organization

This project is allocated into 5 chapters that define the investigation and analytical towards readability of alphabet that produced in the industry which they make labelling on flexible circuit board by using inkjet printer. This project shows the different scale of alphabet on the material that was used as printed circuit board. The quality and readability of printed circuit board will be quantified. The organization of this research study is as follows. This project has been allocated into 5 chapters. Chapter 1 is rough guide to the study that explains about objectives, problem statement, major of study and the project outline.

Chapter 2 begins on the literature background of this study. It discusses on the history of inkjet printer, the mechanisms of model machine inkjet printer that is used, different type of materials that used as printed circuit board and quality of printing. The critical aspect that constituted in this chapter is about the quality and readability flexible circuit board.

Chapter 3 includes details descriptions on the methodology used for research work as a whole, raw materials, process and procedure analysis of the process property that had been done. In this chapter, several samples will be taken to study the size of alphabet and then quality will be determined. Several samples also are from same type of material which is PI Stiffener (polyimide). At the end of the chapter, the expected outcome or result from this study will be provided.

Chapter 4 the result is obtained from the analysis of this result. The result is obtained from the software that gives the value of measurement of the alphabet that has