UNIVERSITI TEKNIKAL MALAYSIA MELAKA

A FEASIBILITY STUDY OF 3D PRINTER PARAMETERS OPTIMIZATION BY USING BAMBOO POWDERS

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

by

ABDUL ALIF BIN ABDUL AZIZ

B050810322

FACULTY OF MANUFACTURING ENGINEERING

2011

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **A Feasibility Study of 3D Printer Parameters Optimization by Using Bamboo Powders**

SESI PENGAJIAN: 2010/ 2011

Saya **ABDUL ALIF BIN ABDUL AZIZ**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (√)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☒	TIDAK TERHAD	

Disahkan oleh:

_____ (TANDATANGAN PENULIS)

_____ (TANDATANGAN PENYELIA)

Alamat Tetap:

No 29, Hala Lapangan Perdana 8,
Panorama Lapangan Perdana,
31650, Ipoh, Perak.

Cop Rasmi:

Tarikh: 14 APRIL 2011

Tarikh:

** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled "A Feasibility Study of 3D Printer Parameters Optimization by Using Bamboo Powders" is the results of my own research except as cited in references.

Signature	:	.....
Author's Name	:	ABDUL ALIF BIN ABDUL AZIZ
Date	:	APRIL 2011

APPROVAL

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

(Signature of Supervisor)

……

(Official Stamp of Supervisor)

ABSTRAK

Dalam arus pembangunan kejuruteraan kini, penghasilan bentuk 3dimensi secara komersial menggunakan teknologi *rapid prototyping* sudah menjadi salah satu kepentingan. Penghasilan model menggunakan cara konvensional dengan ukuran yang tepat adalah memerlukan modal tinggi serta peruntukan masa yang lama. Dengan teknologi bidang penghasilan model, *ZPrinter 310 plus* adalah salah satu mesin pencetak 3dimensi yang telah digunakan untuk menghasilkan model 3dimensi melaui lukisan dari model *CAD*. Bentuk model yang dihasilkan oleh pencetak hasil gabungan dari beberapa asas penting seperti powder dan binder. Beberapa persiapan dan parameter yang harus diberi keutamaan untuk menperoleh hasil yang optimum. Kajian ini memberi fokus utama kepada kesan pelaksanaan parameter yang berbeza dengan menggunakan serbuk buluh sebagai bahan utama. Tujuan dari penelitian ini adalah untuk mempelajari dan memperoleh nilai parameter yang terbaik dengan menggunakan buluh sebagai bahan utama dan di gabungkan dengan tiga jenis bahan pengikat. Ujian kekasaran permukaan dan ujian pengukuran akan dijalankan keatas model yang diperolehi, hal ini adalah untuk tujuan menentukan perbezaan antara parameter- parameter yang telah di laraskan. Data yang diperolehi akan di analisis menggunakan perisian Minitab. Taguchi adalah kaedah yang akan digunakan melalui perisian ini.

ABSTRACT

Nowadays, fabricating 3D shapes in commercial application using rapid prototyping technologies was become one of interest. Creating an accurate model for these objects by hand is extremely time consuming and difficult. By the technology of prototyping field, ZPrinter 310 plus are the one of the 3D Printing machine that has been used for producing 3D model directly from CAD model. The prototype produced by integrated printing function using powder and binder. As consequences, there have several preparations and parameters that must be consider in term of obtaining the optimum result. This study deals with effect of different parameter implementations by using bamboo powder in 3D Printer. The objective of this study is to study the feasibility of the 3D printer machine in producing prototypes when using bamboo powders as raw material with three different proposed binders, to apply different 3D-Printer parameter settings when building up prototypes and to study on the prototypes quality by implement surface roughness and dimensional accuracy testing. Data analysis will be conducted by using Minitab software. Taguchi method will be used in determining the best parameter settings and combinations to obtain the desirable result.

DEDICATION

To my beloved family and friends

ACKNOWLADGEMENT

In the name of ALLAH, the most gracious, the most merciful.

First of all, I am very thankful to ALLAH S.W.T, for giving me strength and opportunity to finish my “Projek Sarjana Muda”. With full of His merciful, now I am writing this report of this project.

I am grateful and would like to express my sincere gratitude to my supervisor Puan Rahimah Bt. Haji Abdul Hamid for her germinal ideas, invaluable guidance, continuous encouragement and constant support in making this study possible. She has always impressed me with his outstanding professional conduct. I am truly grateful for his the time spent proofreading and correcting my many mistakes, his tolerance of my naive mistakes, and his commitment to my future career.

I also sincerely thanks My sincere thanks go to all my lab mates and members of the staff of the Manufacturing Engineering Department, UTeM, who helped me in many ways and made my stay at UTeM pleasant and unforgettable. Many special thanks to them for their excellent co-operation, inspirations and supports during this study.

Last but not least, my special gratitude to my friend for their full support and willingness in solving all problems and tasks. They have given me valuable advices and tips during the preparation of this project. Thank you.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

R_a	-	Arithmetic Average Height
DOE	-	Design of Experiment
RSM	-	Response Surface Methodology
HP	-	Horse Power
V	-	Voltage

CHAPTER 1
INTRODUCTION

1.1 Background

Rapid prototyping is the combination of tools, technologies, and techniques that enable rapid fabrication of early devices that yield the visual and functional characteristics of a final device. Rapid prototyping is useful for many purposes, including rapid vetting of early designs and the determination of a given designs performance or suitability. Essentially, this particular technology provides rapidly try out new product and learn how to modified the idea in order to deliver better performance.

3D printer is the one of rapid prototyping process where a three dimensional object is created by laying down successive layers of material. 3D printers are generally faster, more affordable and easier to use than other additive manufacturing technologies. 3D printers offer product developers the ability to print parts and assemblies made of several materials with different mechanical and physical properties in a single build process. Advanced 3D printing technologies yield models that closely emulate the look, feel and functionality of product prototypes.

However the processing of prototype by using 3D printer with new material must be considered the parameters such as machine setting parameter, the speed of process and the value of thickness material thickness. Those settings are important to define the best quality of surface roughness (Ra) and dimensional accuracy (mm).

Therefore the purpose of this project is to determine the 3D printer parameters optimization by using bamboo powders. 3D printer 310 Manual Plus machine will be used to perform the parameters optimization of bamboo powders.

1.2 Problem statement

In producing the prototype by using 3D printer, the material (powder) used is a priority in order to obtain the best prototype. Bamboo is an alternative that this study involved by use trail approach to explore new material instead of existing material. Hence, the cost of existing material is too high. By founded bamboo as powder that can be used in 3D printer material, indirectly provide variety of material in market. In order to implement that approach, this paper will study and find the appropriate parameter which can be used and the best prevention way for the variable reaction while perform the operation.

Second statement is the existing material that offered in market contains the chemical element. The purpose of bamboo powder have been selected is to encourage the green manufacturing that advice by government and world wide organization to save the environment from global warming. Bamboos are some of the fastest growing plants in the world. They are capable of growing 60 cm (24 in.) or more per day due to a unique rhizome-dependent system. However, the growth rate is dependent on local soil and climatic conditions. Further savings can be realized if the product is designed considering green manufacturing right from its inception. Designing a product that uses a component that has an expensive, environmentally damaging manufacturing process to one that is “green” can have a huge impact on environmental issues.

1.3 Objectives

This study embarks on the following objectives:

i. To study the feasibility of the 3D printer machine (3D Printer 310 Manual Plus) in producing prototypes when using bamboo powders as raw material with three different proposed Z- binders (ZB 56, ZB 60, ZB 51).
ii. To apply different 3D-Printer parameter settings (build orientation, layer thickness and speed) when building up prototypes.
iii. To study on the prototypes quality [surface roughness (R_a) and dimensional accuracy (mm)] with the different settings of 3D printer parameters (Build orientation, Layer thickness and speed).

1.4 Scope of project

The focus of this study is to investigate on the surface quality of 3D Printer prototypes in terms of surface roughness (Ra) and dimensional accuracy (mm) when bamboo powders are utilized instead of the common 3D Printer powders. Different parameter settings will be used in fabricating the prototypes and the effect of these settings to our final prototypes in terms of its quality will be investigated and discussed. In addition, three different Z-binders are proposed to be used while fabricating the prototypes which are ZB 56, ZB 60 and ZB 51. Normally there is a guideline chart provided by the Z-Corp Corporation, which is the provider of our 3D Printer machine which shows which binders are recommended for some powders. Due to the new proposed material in this study, three different binders will be used and the success of fabricating the prototypes with these binders will be discussed. Data analysis will be conducted by using Minitab software. Taguchi method is the method that will be used.

1.5 Important of study

The importance of this study is to investigate how effective bamboo powders are in fabricating prototypes by using 3D printer machine. The effectiveness realized based on several optimizations parameter controls. It is hoped this study will successfully propose a new green material with suitable binder to be used in 3D printer together with the best parameter settings in machine.

1.6 Limitation of the study

In this study, the main focus is in optimizing machine parameters of bamboo powder in term of producing three dimensional designs. The core element is in selecting suitable parameter in 3D 310 Manual Plus machine to adjust the bamboo powder to suit with the design. In this study, the failure by properties of bamboo powder fabricate the prototypes will not be investigated.

1.7 Expected Results

From this study, it is expected to:

i. Investigate the effectivity of bamboo powder with the proposed binder to fabricate parts.
ii. Observe and evaluate any significant effects of different parameter settings on the final quality of 3D Printer prototypes [surface roughness (R_a) and dimensional accuracy (mm)].

CHAPTER 2
LITERATURE REVIEW

This chapter reviews relevant literatures on prototypes process by using Z-Printer 310 Plus machine. Section 2.1 reviews the function of Z-Printer 310 Plus machine and the implementation on the prototyping process. Section 2.2 reviews 3D Printer parameters that relate to that scope on this investigation which are build orientation (part placement), layer thickness (mm) and speed (time). Section 2.3 reviews on mechanical properties of prototype through the prototyping process. Section 2.4 reviews on 3D-printer powder material which states the type and differentiates between powders. There is a review on the significant on surface roughness (R_a) and dimensional accuracy (mm) to the prototyping part in section 2.5. Some previous journals which are investigating the effect of different parameters in 3D printer parts also are reviewed.

2.1 Overview of Rapid Prototyping Technology

Rapid prototyping can be defined as a collection of fabrication methods that make engineering prototype products with minimal lead time through the use of computer aided design (CAD) (Stevens, 2009). Traditionally, prototypes were produced using multiple machining processes that took considerable time and money to produce.

2.1.1 Application and advantage

According to the 310 PLUS User's Manual, the ZPrinter 310 Plus creates physical models directly from digital data. The system is fast versatile and simple, allowing designers and engineers to produce a range of concept models and functional test parts quickly and inexpensively. The system is ideal for an office environment or educational institution, providing product developers' easy access to a 3D Printer. The ZPrinter 310 Plus sleek design and straightforward user interface make it the ideal monochrome rapid prototyping system. In addition, the versatility of the machine allows users to make parts quickly for early concept evaluation and testing, painted parts for a finished look, or patterns for casting applications.

Figure 2.1: Z-Printer 310 Plus

2.1.2 Working principle

The working principle of ZPrint Software by referring to the 310 PLUS User's Manual, first are converts a three-dimensional design file (built using 3D CAD) into cross-sections or slices that are between 0.0035" – .008" (0.0889 - 0.2032 mm) thick. The printer then prints these cross-sections, one after another, from the bottom of the design to the top. Inside the ZPrinter 310 Plus there are two pistons. In the figure below the feed piston is on the left and is shown in the 'down' position filled with powder. The build piston is the piston on the right, shown below in the 'up' position. Also represented in the diagrams is the roller (drawn as a circle) and the print assembly (drawn as a square). On the printer, the roller and the print assembly are mounted together on the gantry which moves horizontally across the build area. To begin the 3D printing process, the printer first spreads a layer of powder in the same thickness as the cross section to be printed. The print head then applies a binder solution to the powder, causing the powder particles to bind to one another and to the printed cross-section one level below. To print the next layer, the feed piston moves up and the build piston moves down, each by the thickness of one layer. The roller then spreads the powder from the feed piston over onto the build piston, and the print assembly prints the pattern of the next layer using binder. The printer keeps repeating this same process over and over until a 3-dimensional part is created in the powder.

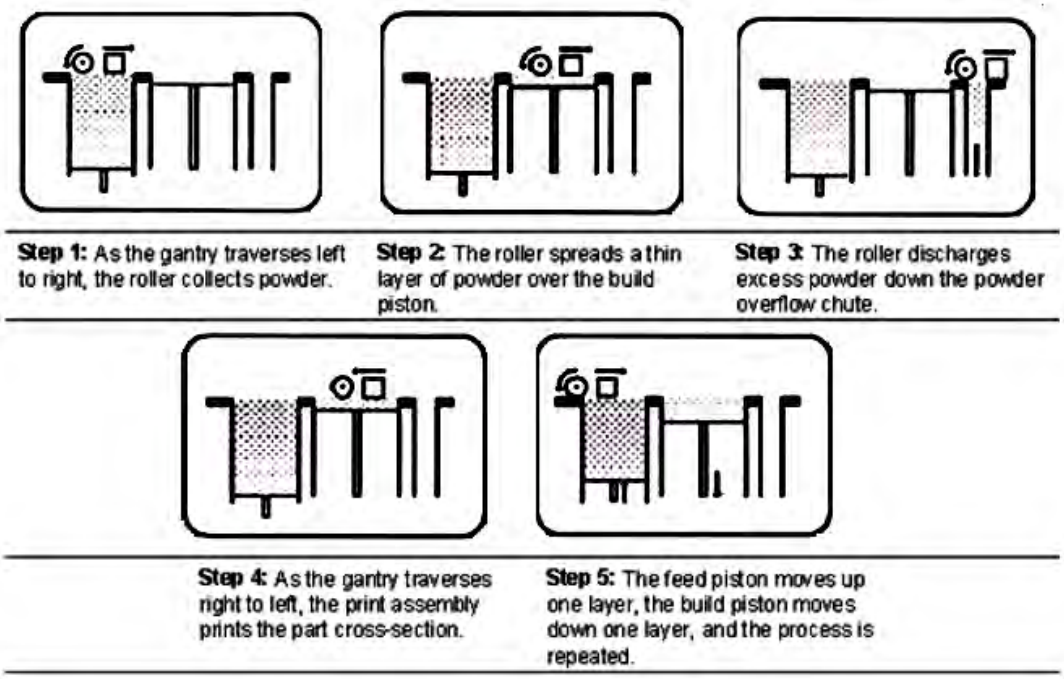

Figure 2.2: Repeating process this same process over and over until a 3-dimensional part is created

2.2 3D Printer Parameters

3D printer is technology of fabricate prototypes by using three dimensional printing technique. Prototypes fabricated from layer by layer combine with binder with perform as adhesive. Consequences, there have several parameters that must be concerns such are build orientation, layer thickness and speed in order to make it process running well.