UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN IMPROVEMENT ON SUPPORT SYSTEM FOR RESIN BASED 3D PRINTER

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

by

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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:

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ABSTRACT

Stereolitography is one of the rapid prototyping systems that can produce a part with high accuracy and good surface finish. Stereolitography is a three-dimensional building process and can produce a solid plastic model. The device that is called Stereolitography Apparatus (SLA) is used to produce the part using stereolitography system. Nevertheless, SLA has its own disadvantages. This apparatus needs support structures. Other than that, there is a problem occurred on the support system. This project presented the research on the support system for resin based 3D printer and E-Darts machine is used for this purpose. Overall system for this machine understands first including support system. Then, the specimen is design using CAD software and produces it using E-Darts machine while the ultraviolet (UV) laser traces two-dimensional cross-sections on the surface of a liquid resin(photosensitive liquid plastic) . Problem occurred on the support system can be examined. Suggestion for designs improvement can be create. The better design is chosen to make an improvement. Thus, the problem occurred on the support system can be reduce.

ABSTRAK

Streolitografi merupakan salah satu sistem rapid prototyping yang boleh menghasilkan sesuatu bahagian (objek) dengan ketepatan yang tinggi dan permukaan yang baik. Stereolitografi merupakan proses pembentukan tiga dimensi dan dapat menghasilkan model pepejal plastik. Peralatan yang dikenali sebagai Aparatus Stereolitografi (SLA) digunakan untuk menghasilkan sesuatu bahagian (objek) meggunakan sistem stereolitografi. Walaubagaimanapun, Aparatus Stereolitografi (SLA) mempunyai keburukan yang tersendiri. Apparatus ini memerlukan struktur sokongan. Selain daripada itu, terdapat juga masalah yang berlaku pada sistem sokongan. Projek ini dijalankan untuk menunjukkan kajian terhadap sistem sokongan bagi pencetak resin tiga dimensi dan mesin *E-Darts* digunakan bagi tujuan ini. Keseluruhan sistem bagi mesin ini difahamkan terlebih dahulu termasuklah sistem sokongan. Kemudian, spesimen direka bentuk menggunakan software Reka bentuk Terbantu Komputer (CAD) dan seterusnya dihasilkan menggunakan mesin E-Darts di mana laser ultra-ungu mengesan keratan rentas pada permukaan cecair resin (cecair plastik fotosensitif). Masalah yang berlaku pada sistem sokongan dapat dikaji. Cadangan bagi pembaikan rekabentuk sistem sokongan dapat diberikan. Reka bentuk yang terbaik akan dipilih untuk dibuat pembaikan. Dengan itu, masalah yang berlaku pada sistem sokongan dapat dikurangkan.

DEDICATION

To my beloved family.

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LIST OF ABBREVIATIONS

ABS – Acrylo-nitrile Butadiene Styrene

CAD – Computer Aided Design

CPU – Central Processing Unit

DSPC - Direct Shell Production Casting

EB - Electron-Beam

FDM - Fused Deposition Modeling

PCA - Post-Cure Apparatus

RP – Rapid Prototyping

RP & M – Rapid Prototyping and Manufacturing

SLA - Stereolithography

SLS - Selective Laser Sintering

UV – Ultra-Violet

2D – Two Dimensional

3D – Three Dimensional

CHAPTER 1
INTRODUCTION

The purpose of this project is to make a design improvement on support system for resin based 3D printer. The basic concept of rapid prototyping must be understand first. Then, support system for resin based 3D printer was studied. By using 3D printer, 3D object can be created by layering a material (plaster, cornstarch, resins) and it consist of an inkjet layering printing system. 3D object can be created with a short time compared to the other method. To examine the problem on support system, the main cause was investigated and step to avoid this problem from occurred again will be done by doing a design improvement on the machine. Some improvement on the support system for resin based 3D machine is needed to make sure that this machine can perform it task with efficient and perfectly. By doing this research this problem can be solved.

1.1 Background

Rapid prototyping (RP) is a terms which embraces a range of new technologies for producing accurate parts directly from CAD models in a few hours, with little need for human (Pham, D.T. and Gault, R.S. (1998)). This means that designers have the freedom to produce physical models of their drawings more frequently, allowing them to check the assembly and function of the design. RP technologies may be divided into the addition material and removal material. The most popular among currently available RP technologies is perhaps stereolitography.

Stereolithography is an additive fabrication process utilizing a vat of liquid UV-curable photopolymer "resin" and a UV laser to build parts a layer at a time (Kalpakjian,S. and Schmid, S. (2000)). On each layer, the laser beam traces a part cross-section pattern on the surface of the liquid resin. Exposure to the UV laser light cures, or, solidifies the pattern traced on the resin and adheres it to the layer below. Stereolithography requires the use of support structures to attach the part to the elevator platform and to prevent certain geometry from not only deflecting due to gravity, but to also accurately hold the 2-D cross sections in place such that they resist lateral pressure from the re-coater blade. Supports are generated automatically during the preparation of 3-D CAD models for use on the stereolithography machine, although they may be manipulated manually. Supports must be removed from the finished product manually; this is not true for all rapid prototyping technologies.

1.2 Problem Statement

Rapid prototyping is a most popular method to produce a product with a short time, low cost and easy to use. There are many types of rapid prototyping system for example stereolithography (SLA), selective laser sintering (SLS), fused deposition modeling (FDM), direct shell production casting (DSPC), 3D printers and direct fabrication processes. Stereolitography is a type of rapid prototyping system. This is a method and apparatus to produce solid objects by successively "printing" thin layers of the curable material and inkjet printing system will be used. The apparatus that is used to produce a part using this system is E-Darts machine. This machine not always can be function perfectly and requires support structures. Structures that have overhangs and undercuts must have supports that are designed and fabricated together with the main structure. The problem may be occurred on this machine for example on the support system. This project will be performing to examine the problem and design an improvement for this support system.

1.3 Objective

Objective of this project are:

a) To understand the basic concept for rapid prototyping system.
b) To understand about the operation of resin based 3D printer
c) To examine the problem occurred on the support system for resin based 3D printer.
d) To design an improvement on the support system for resin based 3D printer.
e) To examine the improvement of the resin based 3D machine.

1.4 Scope

This project will be concentrate on resin based 3D printer which can produce prototype with faster compared to the other method. The machine that will be used is E-darts machine. This machine will be operating to produce the specimen. Problem on this machine will be examined. By examine the cause of this problem the solution can be make and improvement on this machine also can be done by crate new design of the support system.

CHAPTER 2

LITERATURE REVIEW

2.1 Rapid Prototyping

2.1.1 What Is The Rapid Prototyping?

In the development of a new product, there is invariably a need to produce a single example or prototype of a designed part or system before the allocation of large amounts of capital to new production facilities or assembly lines (Kalpakjian,S. and Schmid, S. (2000)). The main reasons for this need are that the capital cost is very high and production tooling takes considerable time to prepare. Consequently, a working prototype is needed for design evaluation and troubleshooting before a complex product or system is ready to be produced and marketed.

Rapid prototyping systems have become commercially available; they can offer a significant reduction in the product development life cycle (LIU, S. and WANG, Z. (1998)). Currently, most of the basic research work on rapid prototyping is focused on the development of new materials or techniques for deposition. New application-based research is critically needed to make the rapid prototyping technology more cost-effective, efficient and versatile, particularly during the part design, process planning and support design stages.

2.1.2 Classification of the Rapid Prototyping Processes

Rapid Prototyping is a technology that also can be called as solid free from fabrication. Rapid prototyping process can be divided into three different groups: subtractive, additive and virtual processes. Subtractive process will remove the material from a workpiece. The workpiece is larger than the final part. While the additive process will build up a part by adding the material to produce the final part. Virtual process will use an advanced computer-based visualization technologies. According to Kalpakjian, S. and Schmid, S the computational steps in producing a stereolitography file is shown in figure below.

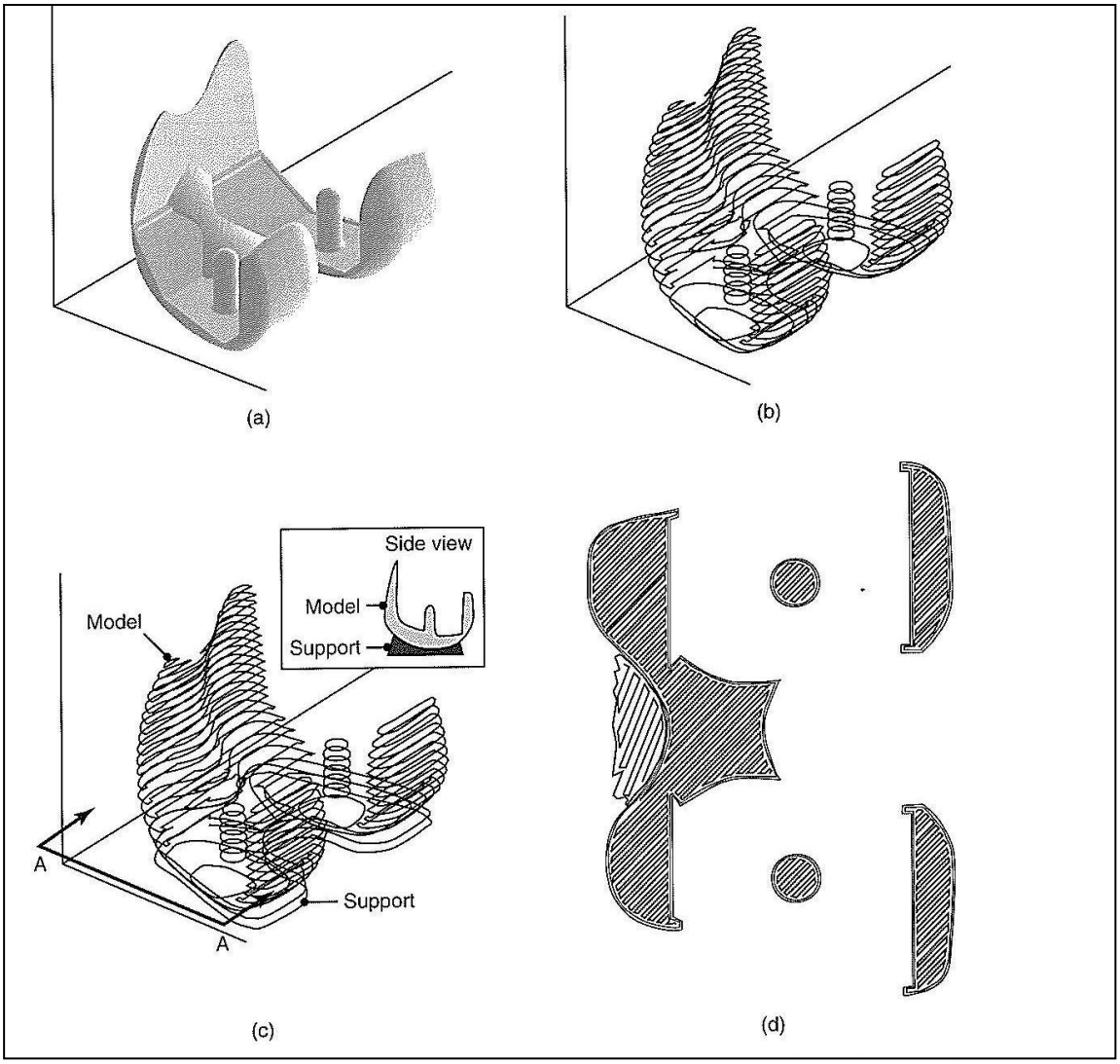

Figure 2.1: The computational steps in producing a stereolitography file.

(a) Three-dimensional description part.

(b) The part is divided into slices (only one in 10 is shown).

(c) Support material is planned.

(d) A set of tool directions is determined to manufacture each slice. Also shown is the extruder path at section A-A from (c) for a fused-deposition-modeling operation.