UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DIMENSIONAL ACCURACY OF THE PLATINUM FARO ARM FOR REVERSE ENGINEERING PRODUCTS USING FUSED DEPOSITION MODELING

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

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2015

ABSTRAK

Projek ini adalah bertujuan untuk mengkaji ketapatan produk yang dihasilkan dengan mengunakan Fused Deposition Modeling (FDM). Cara ini digunakan secara meluas oleh syarikat industri untuk menghasilkan satu prototaip. Produk yang dipilih akan diukur terlebih dahulu menggunakan angkup vernier sebelum melukis dengan mengunakan perisian SolidWork. Produk juga akan diimbas dengan mengunakan Platinum Faro Arm. Selesai proses mengimbas produk, fail STL akan dihantar kepada FDM mesin untuk menghasilkan produk. Bahan yang digunakan untuk proses penghasilan adalah daripada Acryclonitrile Butadiene Styrene (ABS). Bagi mengetahui ketepatan produk itu, 'Coordinate Measuring Machine' digunakan untuk merekod data ukuran bagi setiap ukuran kritikal yang telah ditentukan. Masalah yang dihadapi semasa proses imbasan produk adalah kurang kemahiran mengunakan mesin tersebut, serta kekangan masa dan tiada pengalaman cara pengunaaan software Geomagic. Keputusan daripada proses imbasan produk telah dibincangkan dalam Bab 4 untuk setiap produk yang dihasilkan. Produk prototaip akan dibandingkan dengan produk sebenar untuk mengetahui ralat yang telah dihasilkan. Kesimpulannya, bagi menghasilkan satu produk yang tepat ada beberapa cadangan telah diterangkan untuk penambahbaikan untuk masa akan datang.

ABSTRACT

This project is aimed to investigate the accuracy of products produced using Fused Deposition Modeling (FDM). This method is widely used by industrial companies to produce a prototype. The selected products will be measured in advance using a vernier caliper and draw using SolidWork software. Also, the product will be scanned using the Platinum Faro Arm. After completing the process of scanning the product, the STL file will be sent to the FDM machine to produce the product. The materials used for the production process is Acryclonitrile Butadiene Styrene (ABS). To determine the accuracy of the product, 'Coordinate Measuring Machine is used to record the measurement data for each critical dimension Problems encountered during the scan process using the product are lack of skills to operate the machines, as well as time constraints and no experience in using of Geomagic software. The results of the scan process products discussed in Chapter 4 for every product. Prototype products will be compared with the actual product to find the error was generated. In conclusion, to produce a perfect product there are some suggestions for improvement as described for the future work.

DEDICATION

To my lovely parents, my brother and sister who give me encouragement to success in my studies and not to forget special thanks to all my lecturers and friends that give me guideline and support during my study in Universiti Teknikal Malaysia Melaka (UTeM)

ACKNOWLEDGEMENT

Firstly I would like to thank of Almighty Allah for His blessing for his power for me to complete this project successfully. I would like to forward my utmost gratitude to my supervisor, Encik Baharudin bin Abu Bakar for being my supervisor, also give me guideline and inducement to complete my project which is "Dimensional Accuracy Of The Platinum Faro Arm For Reverse Engineering Products Using Fused Deposition Modelling".

I would like to send my appreciation to all technician that help me, especially to technician at Platinum Faro Arm Encik Fairuz bin Ninggal, FDM Machine Encik Hairuddin bin Kanan and also assistant engineer Encik Sahar bin Salehan.

Lastly I would like to thanks to my parents Abdullah Hapipi bin Daimon and Norlidah binti Ayob because always support me and give me advice until I completing my Final Year Project. Also, my sincerely appreciation to all my friend who helping me in completion of this project.

Thank You.

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LIST OF ABBREVIATION

FDM	-	Fused Deposition Modeling
ABS	-	Acrylonitrile Butadiene Styrene
3D	-	Three Dimensional
RP	-	Rapid Prototyping
R&D	-	Research and Development
NC	-	Numerical Control
CAD	-	Computer Aided Design
STL	-	Tesselation
SLC	-	Stereolithography Contour
CLI	-	Common Layer Interface
SLA	-	Stereolithography
LOM	-	Laminated Object Manufacturing
RE	-	Reverse Engineering
CAE	-	Computer Aided Engineering
CMM	-	Coordinate Measuring Machine
CAM	-	Computer Aided Manufacturing

CHAPTER 1

INTRODUCTION

1.1 Background

The growth of engineering field is faster. Many companies have to compete each other to produce new products in the manufacturing industries. New product, technology and system have been introduced to identify the best solution to fulfil their customers demand and satisfaction. Rapid Prototyping and Reverse Engineering are the new technologies that now all the companies have been used for this purpose. These technologies will make the engineering field easier to get better dimensional accuracy, easier to produce, lower cost and analysis for any parts or products.

Rapid prototyping is the combination of tools, technologies, and technique that enable rapid fabrication of early devices that yield the visual and functional characteristics of the final device. Rapid prototyping is useful for many of purpose, including rapid vetting of early designs and the determination of a given design performance or suitability.

Rapid prototyping is important in the process of design and quite beneficial as far as decrease the project cost and risk in manufacturing. Rapid manufacturing is powerful technology in new revolution application. The process is more faster to develop prototype or working a model for any king of design, feature, concept, functionality and performance.

1.2 Problem Statement

Rapid prototyping is a modern technology that is faster method to produce product than conventional method. However, in Rapid Prototyping also have some disadvantage which is the product that product produced by Fused Deposition Modelling (FDM) are not consistently measured accurately as compared to the actual product measurement.

From this problem, we will carried out that the product dimensions by product drawing and scanned drawing and produced by FDM. The measurement of dimensions under repeated FDM production is not consistently accurate.

1.3 Objective

The objectives of the study are:

a) To study the dimensional accuracy of Reverse Engineering products using Platinum Faro Arm and FDM machine.
b) To investigate the accuracy of the prototype produced by FDM and compared to the actual product.

1.4 Scope of study

In this research is to study the dimensional accuracy of Reverse Engineering products under scanned using the Platinum Faro Arm and produced on FDM. Acrylonitrile butadiene styrene (ABS) is chosen for the material of Fused Deposition Modeling (FDM) to make the prototyping of product.

CHAPTER 2

LITERATURE REVIEW

2.1 Rapid Prototyping

Rapid prototyping are technique that in used to produce a solid model or physical models from three dimensional (3D) Computer Aided Design data. The 3D printing machine allow for engineer or designers to quickly create a real prototypes of their design Chapela *et. al* (2013). RP represent a method that applied modern manufacturing technologies to produce parts on layer by layer. These methods are less time used up compared with conventional method. Utilize of RP will increases the dependability of the product and profit of manufacturing. Rapid prototyping are one and only of the names applied to a new group of technologies for converting designs from computer representations instantly into solid objects without human intervention. No single one of the many technologies has yet proven that it can meet all market requirements, so those intending to be involved in this industry should know the fundamental processes, limits, and potentials of the competing machines.

Rapid Prototyping are excellent visual aids for communicated ideas with workers and customers for testing the functionality of devices or machines. In addition, the models from rapid prototyping technique are used to create of models for tooling machine such as silicone rubber molds and investment casts.

The term "rapid" as it applies to RP technologies is relative. Even the fastest RP fabrication process can take from 3 to 72 hours, depending on the size and complexity of the prototype. Nevertheless, all of these methods are faster than the weeks or even months required to fashion a prototype by traditional hand-crafted carving or machining methods (Singh., 2013).

Rapid prototyping is a global industry that now includes manufacturers of prototype building equipment, contract prototype building services, and companies that perform both manufacture of equipment and offer building services. The importance of this RP industry can be seen from the growing list of participants in equipment manufacture and building services in the United States, Canada, South and Central America, Europe, and Asia. RP model-making equipment is being sold for in-house use by manufacturers, government and corporate R&D laboratories, and the engineering departments of vocational schools and universities.

2.1.1 History of Rapid Prototyping

Rapid prototyping is the useful steps to describe a product design. It are implemental in conceptual of design. The product will tried and manufacture before the full production will set up. Secondly stage of prototyping are began around mid-1970s, once a soft prototype modelled by 3D curves and surfaces could be emphasis in surrounding environment, tested, and modelled on exact material and some other properties.

Next stage and the newest trend of prototyping for example RP product layer by layer material deposition, it began on early 1980s with the large growth in Computer Aided Design and Manufacturing (CAD/CAM) technologies when almost straightforward solid model with knitted information of edged and surface could define as a product. The historical developing of RP and related technologies is representing in table 2.1. (Chua, Leong. K, K.F.,2000)

Table 2.1: The Historical Development of RP and Related Technologies

Year of inception	Technology
1770	Mechanization
1946	First computer
1952	First Numerical Control (NC) machine tool
1960	First commercial laser
1961	First commercial robot
1963	First interactive graphics system (early version of Computer Aided Design)
1988	First commercial Rapid Prototyping system

The earlier usage of additive manufacturing was in rapid prototyping (RP) on the late 1980s and early on 1990s. Prototypes admit manufacturers a chance to examine an object's design more closely and even test it before producing a finished product. RP allowed producer produce those prototypes much quicker than before, often within daytimes or sometimes hours of conceiving the design. In designers, RP create models using computer-aided design (CAD) software, and then machines follow that software model to find out how to build the object. The process of building that object by "printing process" it has cross-sections layer by layer became known as 3-D printing.

At the beginning of the 1990s FDM and three dimensional printing were invented. In the FDM technique, unlike in other processes, the object is printed in an open space, with no support of an unused material, which would serve as support for more complicated structures. The most frequently used material in FDM prototyping is acrylonitrile butadiene styrene (ABS); however, other materials are also utilized, including polycarbonate, polyphenylsulphone, and elastomers.

2.1.2 Basic Principle of Rapid Prototyping Processes

The Rapid Prototyping process consist to the addictive production procedure that not equivalent with shaping or reductive processes. As commercialise RP processes, the part is fabricated by deposition of layers contoured in an x-y plane two dimension. For the third dimension z outcome are from single layers being stacked up on top of each other, but not as a continuously z-coordinate. So that, the prototypes are very accurate on the x-y plane but have stair stepping consequence in z-direction. Rapid Prototyping also can be classified into two basic process steps namely generation of mathematical layer data and generation of physical layer model (Pandey *et. al.*,2003a)

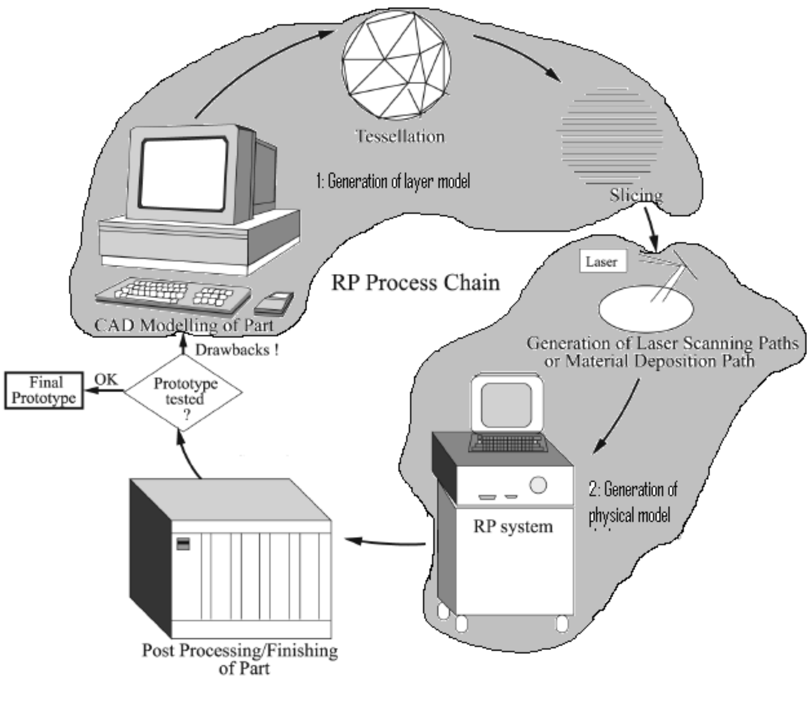

Figure 2.1: Rapid Prototyping Process

The figure 2.1 that process starts with 3D modeling of the product and then STL file is exported by tessellating the geometric 3D model. In tessellation various surfaces of a CAD model are piecewise approximated by a series of triangles (Figure 2.2) and co-ordinate of vertices of triangles and their surface normal are listed. These STL files are checked for defects like flip triangles, missing facets, overlapping facets, dangling faces or edges etc. and are repaired if found faulty. Defect free STL files are used as an input to various slicing software. At this stage choice of part deposition orientation is the most important factor as part building time, surface quality, amount of support structures, cost etc. are influenced. Once part deposition orientation is decided and slice thickness is selected, tessellated model is sliced and the generated data in standard data formats like SLC (stereolithography contour) or CLI (common layer interface) is stored.

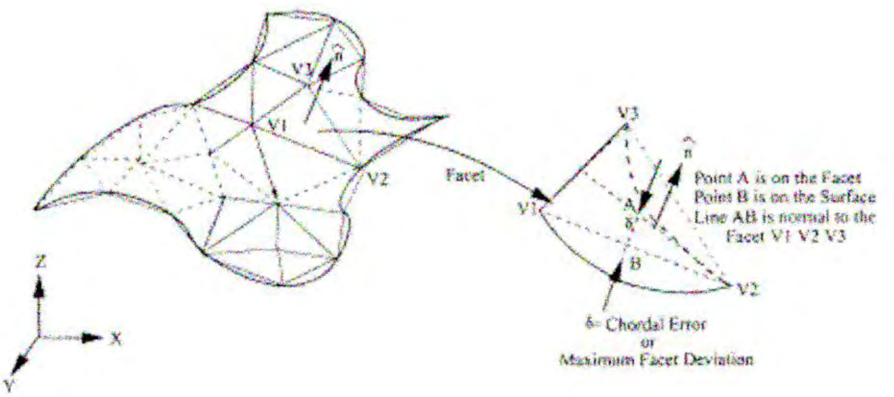

Figure 2.2: Tessellation of a Typical Surface of CAD Model

The last step in the process chains are the post-processing project. At these level, normally a few manual processes are necessary therefore skilled operator is required. In cleaning, excess elements adhered with the part or support structures are moved out. Occasionally the surface of the model is completed by sanding, polishing or painting for better surface finish or aesthetic appearance. Prototype is then tested or verified and proposes engineering switches are again incorporated during the solid modeling stage.