UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Reverse Engineering of Hand Phone Housing Plastic Injection Molding

Thesis submitted in accordance with the requirements of the Universiti Teknikal Malaysia Melaka for the Bachelor of Manufacturing Engineering (Design)

By

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BORANG PENGESAHAN STATUS TESIS*

JUDUL: **REVERSE ENGINEERING OF HAND PHONE HOUSING PLASTIC INJECTION MOLDING**

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I hereby, declare this thesis entitled "Reverse Engineering of Hand Phone Housing Plastic Injection Molding" is the results of my own research except as cited in the reference.

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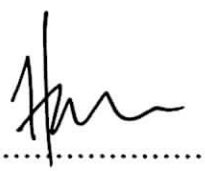
APPROVAL

This thesis submitted to the senate of UTeM and has been accepted as fulfillment of the requirement for the degree of Bachelor of Manufacturing Engineering (Design). The member of the supervisory committee is as follows:



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ABSTRACT

From this study of Reverse Engineering of Hand Phone Housing Plastic Injection Molding, all the work that had been done is planned first to achieve the main target. The overall objective of this study is to develop a methodology to reverse engineer the hand phone cover by using certain chosen method. To approach this goal, the methodology proposed has certain method that were identifying the product, measure the product to be solid modeling, produce a solid model of the chosen product by using 3D scanner and Solid Works, analyze the product by using CosmoXpress and MoldFlowXpress and lastly to design the mould for the hand phone housing parts. As a first step, the product of Nokia 6680 is chosen as the study product based on its popularity and the current technology. A measurement process is done after that by using CMM and vernier caliper. Then, solid model of Nokia 6680 is gained by using Solid Works and 3D scanner. This study allows the learning of new knowledge such as 3D scanner and new software such as Dr Picza and Roland Pixform 3d Scanner. From the result of the digitizing and 3D solid model, the prototype of the hand phone is produce by the rapid prototyping machine. The prototype is used to compare the result of the digitizing process with the real hand phone housing. The prototype also is used to be the specimen of assembling process. If anything happen, the prototype is referred to adjust any wrong dimension which is lead to the assembling failure. The mould of the hand phone housing is done after the dimension is correct and the analysis is done. The analysis is including the reducing part of the current design and the analysis of the mold flow process.

ABSTRAK

Daripada kajian kejuruteraan berbalik acuan suntikan plastik untuk perumah telefon bimbit, segala kerja yang dibuat telah dirancang terlebih dahulu untuk mencapai matlamat utama. Secara keseluruhan, kajian ini dibuat untuk menghasilkan kaedah kejuruteraan berbalik untuk perumah telefon bimbit dengan menggunakan sesetengah kaedah yang terpilih. Bagi mencapai matlamat ini, kaedah yang digunakan adalah mengenalpasti produk yang akan dikaji, mengukur produk, membuat model untuk produk yang telah dipilih menggunakan 3D Scanner dan SolidWorks, menganalisa produk dengan menggunakan CosmoXpress dan MoldFlowXpress dan akhirnya merekabentuk acuan untuk perumah telefon bimbit. Sebagai langkah pertama, produk Nokia 6680 dipilih untuk dikaji berdasarkan populariti dan juga teknologinya yang canggih. Seterusnya, process pengukuran dibuat menggunakan CMM dan juga angkup vernier. Kajian ini adalah satu pembelajaran kepada pengetahuan baru seperti 3D Scanner dan pengisian computer seperti Dr Picza dan Roland Pixform 3d Scanner. Daripada keputusan pengukuran dan juga model 3d, prototaip telefon bimbit dibuat menggunakan mesin prototaip. Prototaip ini digunakan untuk process penggabungan. Jika terjadi sebarang kesilapan,prototaip itu akan dirujuk untuk membetulkan sebarang kesilapan pada model telefon bimbit. Acuan telefon bimbit akan dibuat selepas semua ukuran tepat dan analisis dibuat. Analisis yang dimaksudkan termasuklah pengurangan bahagian dalam rekabentuk sebelumnya dan juga proses pengaliran dalam acuan.

DEDICATION

For my parents, Said bin Long dan Siah binti Abu Bakar, for my siblings and friends.

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First of all, thanks God I finally finish my Projek Sarjana Muda successfully.

I would like to express my warmest gratitude to my supervisor Mr. Hassan bin Attan and to my second supervisor, Mr Taufik. Your guidance, advices, ideas and positive admonitions means a lot to me and help me so much in finishing my project.

I would like to thanks Universiti Teknikal Malaysia Melaka especially Manufacturing Department for providing laboratories and library facilities that is really help me in completing my project.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

This reverse engineering of hand phone housing plastic injection mold is done due to its advantages in reducing production cost and to shorten the development process. The reverse engineering is a process that used to create 3D CAD (Computer Aided Design) models directly from physical parts with accurate dimension. This is used in order to redesign a product for better manufacturability. Usually, high technology and modern manufacturing method is used so that a component can be quickly and accurately reverse engineered. For a product of hand phone housing, the most important thing that should be considered is the dimension and tolerance of each part and features because each part is connected to one another and a problem will occur if the dimension is not accurate. A good design of core and cavity is needed to produce a perfect product.

This study is focused on the methodology and the application of reverse engineering to produce the hand phone housing mould. The application of the reverse engineering is applied according from the first to the last process. First, a sample of the parts or drawing must be provided. Then, the parts or object is digitized. After that, the taken data is refined to create a 3D model. For this study, a type of hand phone housing had been chosen from many type of the other product. The criteria of the chosen hand phone design is based on the popularity and trend currently. This hand phone is chosen based on its popularity and current trends especially among UTEM's student.

As computer-aided design has becoming more popular, reverse engineering has become a viable method to create a 3D virtual model of an existing physical part for use in 3D CAD, CAM, CAE and other software. The reverse engineering process involves measuring an object and then produces a 3D model. The physical object can be measured using 3D scanning technologies like CMMs and laser scanners or other handling tool such as vernier caliper. CAM is Computer Aided Manufacturing that involves the use of computers to assist in all phases of manufacturing a product. (Serope Kalpakjian, Manufacturing Engineering and Technology fifth edition, 2006)

1.2 The objectives of the research

The objective of the study is to develop and redesign the product with the application of the reverse engineering process. This study is requires the student to be creative and apply reverse engineering tools and experience high and research technology that is not experienced in their learning education classes. The main focused in this study is to build a core and cavity for hand phone housing with the application of reverse engineering, to analyze the important of each part in hand phone cover to improve its design and to analyze the injection molding process in producing the product.

The main objectives of the research are:

1. To determine the dimension of the hand phone housing by using the best existing equipment at UTEM.
2. To select the material, based on suitable composition, properties, elasticity modulus and poison ratio of the hand phone housing material.
3. To apply the entire related machine in UTEM in order to complete the research.
4. To generate a 3D design of the mould of the hand phone housing.
5. To produce the prototype of the hand phone housing.

1.3 Scope of study

a. This study will be involves the literature review of reverse engineering, mould, injection molding, reverse engineering tools and software used.
b. To apply reverse engineering method is to obtain the solid model of hand phone housing and detail design of existing product.
c. To study features of existing product and minimize if possible.

1.4 Problem statement

The study is done to mold for hand phone housing of Nokia 6680. The design of the mold can reduce the production time of the product in the future beside to reduce the cost of the production. Nokia 6680 is already existed in market, so a reverse engineering is important to redesign the hand phone housing for other usage. A reverse engineering is a way to reduce the development process and reduce the production costs of a product and this will clearly show us the importance of the hand phone housing to be reverse engineer to enhance the product.

1.5 Research

1.51 3D Laser Scanner

A Reverse engineering process of a mechanical component requires a precise digital model of the objects to be reproduced. A 3D scanner can be used to digitize free-form or gradually changing shaped components as well as prismatic geometries whereas a coordinate measuring machine is usually used only to determine simple dimensions of a highly prismatic model. These data points are then processed to create a usable digital model. The type of 3D scanner includes the laser, Destructive, Mechanical Probe, Time

of Flight and X-Ray. Within the broader topic of 3D Laser Scanning, there are two types of device which operate in different ways and produce radically different results:

1. Triangulating 3D Laser Scanners

2. Time of Flight 3D Laser Scanners.

1.52 Coordinate Measuring Machine (CMM)

A Coordinate-measuring machine (CMM) is a device for dimensional measuring. It is a mechanical system designed to move a measuring probe to determine the coordinates of points on the surface of a work piece. The CMM is used to measure dimensions which are critical in tolerance and difficult to be determine using conventional method.

1.53 Vernier Caliper

A caliper is a device that used to measure the distance between two symmetrically opposing sides. A caliper can be as simple as a compass with inward or outward-facing points. The tips of the caliper are adjusted to fit across the points to be measured, the caliper is then removed and the distance read by measuring between the tips with a measuring tool, such as a ruler. A vernier caliper is used in the metalworking field of mechanical engineering, and in woodworking and woodturning.

1.54 Injection Moulding

The process of injection molding is used to produce large quantities of identical plastic items. Injection moulding is the most important plastics manufacturing process. It produces such small products as bottle tops; sink plugs, children's toys, containers,

model kits, disposable razors and parts of cameras. It is also used to manufacture larger items such as dustbins, and milk crates. The process can even mould such large items as dingy hulls and kit car body shell parts. Injection moulding used to be operated by people on the factory floor but these days it is a form of highly automated form of production. There was not all the polymers is possible to be injection mold. This will be later explained in the next chapter. (Product Design for Manufacture and Assembly second edition, Winson Knight,2002)

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter is all about the information that related to the study such as the methods that had been used by the others in reverse engineering process. This information is important to this study due to the applicable of it to complete this study. This research also is the best way to guide student with the problem encountered during the completion of this study. The application of the research may help student to perform a good job in this study because of the much information to understand of what they are looking for. This research review includes facts and studies of current reverse engineering tools. The tools used are the Coordinate Measuring Machine (CMM) and vernier caliper.

2.2 Reverse engineering

Reverse engineering is the process of extracting the knowledge of design blue- print from anything man-made and the concept is begun before computers or modern

technology. The reverse engineering is the main study (Reversing: Secrets of Reverse Engineering by Eldad Eilam). The research of the reverse engineering could be use to obtained knowledge and understands the part to be design clearly. The data obtained from this study can be used to manufacture this product in the future. Reverse engineering usually is used by military in order to copy other nation's technology, devices or information. (figure 2.2)

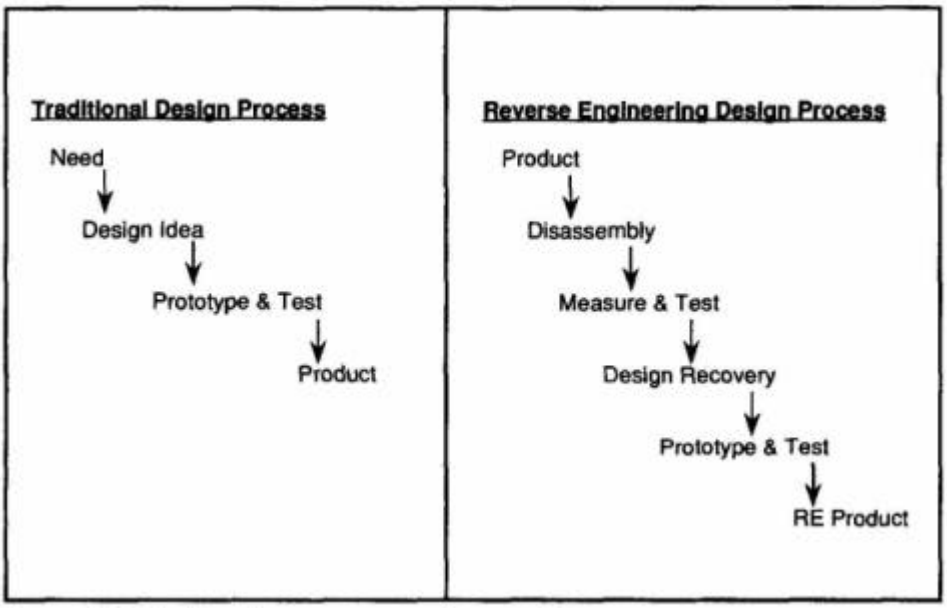

Figure 2.2: Traditional versus reverse engineering process

(Reverse Engineering by Kathryn A. Ingle**)**

Advantages of Reverse engineering:

- Make fast availability of CAD models
- The physical model is used as the starting point
- Shortened development process of a product
- Developed product at the start of production
- Reduce the product and production costs
- Powerful point cloud data collection and management
- Flexibility for demanding Rapid Prototyping and Rapid Tooling.

Potential uses of Reverse engineering

- The development of CAD models based on physical ones
- Editing a CAD file using the altered physical model
- Creating STL files for use in other Rapid Prototyping techniques

Reverse engineering is the process of analyzing a subject system to create representations of the system at a higher level of abstraction. Reverse engineering is a process that discovers the technological principles of an object or system through analysis of its structure, function and operation. During complete a reverse engineering project it often involves mechanical device, electronic component, or a software program apart and analyzing its functions in detail. Usually, reverse engineering process is construct a new device or program that does the same thing without actually copying anything from the original. Reverse engineering is also to bring existing physical geometry into digital product development environments, to make a digital 3D record their own products or assess competitors' products. It is used to analyze, for instance, how a product works, what it does, what components it consists of, estimate costs, identify potential patent infringement. Reverse engineering also often is done because the documentation of a particular device has been lost, and the person who built the thing is no longer working at the company. Integrated circuits often seem to have been designed on obsolete, proprietary systems, which means that the only way to incorporate the functionality into new technology is to reverse-engineer the existing product and then re-design it.

One of the main processes of reverse engineering is the digitizing process. Digitizing process is done to the reverse engineered part by using the suitable tool depends on the part. Currently, there is too much high technology tool that had been used in reverse engineering to measure the physical object by using 3D scanning technologies like CMMs, laser scanners (figure 2.2a), ATOS, white light digitizers (figure 2.2b) or computed tomography. The measured data alone, usually represented as a point cloud, lacks topological information and is therefore often processed and modeled into a more usable format such as a triangular.

Figure 2.2 (a): 3D Laser Scanner

Figure 2.2 (b): White Light Digitizers

ATOS

ATOS (figure 2.2c) is the high-end 3D Digitizer which is flexible optical measuring machine is based on the principle of triangulation. Projected fringe patterns are observed with two cameras. 3D coordinates for each camera pixel are calculated with high precision, a polygon mesh of the object's surface is generated. 3D digitizing with the mobile ATOS system delivers for all object sizes and complexities with the specialty to:

1. Highly accurate 3D coordinates
2. Full-field deviation to CAD
3. Section based analysis
4. Complete measuring reports

With the high performance, enormous detail resolution and broad selection of measuring areas allow for an efficient and precise data gathering and reporting in:

1. Quality Control
2. Reverse Engineering
3. Rapid Prototyping
4. Rapid Milling
5. 

Figure 2.2 (c): ATOS