UNIVERSITI TEKNIKAL MALAYSIA MELAKA

REVERSE ENGINEERING OF SPUR GEARBOX

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Mechanical Engineering Technology (Maintenance Technology) (Hons.)

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor Mechanical Engineering Technology (Maintenance Technology) (Hons.). The member of the supervisory is as follow:

…………………………

(Ir Mazlan bin Ahmad Mansor)

ABSTRAK

Perusahaan pembuatan yang memberi tumpuan kepada penyampaian peningkatan produktiviti dengan produk yang berkualiti tinggi melalui integrasi reka bentuk berbantu komputer (CAD) serta berbantu komputer pembuatan (CAM) dan alat kejuruteraan bantuan komputer (CAE). Dalam pasaran global yang sangat kompetitif hari ini, perusahaan produk sentiasa mencari cara-cara baru untuk memendekkan masa utama bagi pembangunan produk baru yang memenuhi semua jangkaan pelanggan. Tujuan kajian ini adalah untuk menghasilkan lukisan 2D dengan spesifikasi industri dan menghasilkan data CAD dengan kaedah kejuruteraan terbalik. Laporan ini memberi tumpuan kepada kajian pengenalan, kajian literatur dan juga kaedah pemodelan dan analisis menggunakan perisian kejuruteraan komputer. Kertas ini membentangkan kejuruteraan (RE) terbalik untuk menunjukkan bagaimana CAD dan CAE sistem yang dilapisi terhadap reka bentuk produk untuk memberikan matlamat yang lebih berkualiti. Secara umumnya kertas ini mengetengahkan maklumat yang sesuai mengenai geometri, pendimensian dan Toleransi (GD&T) . Pendimensian geometri dan toleransi (GD&T) digunakan sebagai alat pengesahan untuk perbandingan model CAD yang dijana.

ABSTRACT

Most manufacturing enterprises focus on the delivery of increased productivity with high quality products through integration of computer aided design (CAD), computer aided manufacturing (CAM) and computer aided engineering (CAE) tools. In today's intensely competitive global market, product enterprises are constantly seeking new ways to shorten lead times for new product developments that meet all customer expectations. The purpose of this study is to produce 2D drawing with industrial specifications and developed a CAD data with reverse engineering method. This paper focused on the study of introduction, literature review and also methodology of modelling and analysis using computer engineering software. This paper presents a reverse engineering (RE) scenario to show how CAD and CAE systems are overlaid on product design to realize the goals of better quality and productivity of scanned CAD models used for maintaining and inspection purposes. Generally this paper highlights appropriate information about geometric, dimensioning and tolerance (GD&T). Geometric dimensioning and tolerance (GD&T) is used as a validation tool for comparison of the CAD models generated.

DEDICATION

This thesis dedicate to my parents and my friends for supporting me all the way.

ACKNOWLEDGEMENT

First and foremost, I would like to take a deepest appreciation to my supervisor Ir Mazlan bin Ahmad Mansor from the Faculty of Engineering Technology, Universiti Teknikal Malaysia Melaka for his essential supervision, patience, motivation, enthusiasm, and immense knowledge towards the completion of this project. I would also like to express my deepest gratitude to my classmates for their continuous support throughout the achievement of this project. Not to forget hanks to my beloved mother. Your prayer for me was what sustained me this far. I would also like to thank all of my friends who supported me in writing, and incanted me to strive towards my goal.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

RE	-	Reverse Engineering
CAD	-	Computer Aided Design
3D	-	Three Dimensional
ACME	-	Trapezoidal thread forms
CAM	-	Computer Aided Manufacturing
CAE	-	Computer Aided Engineering
CMM	-	Coordinate Measuring Machine
IGES	-	Initial Graphics Exchange Specification
STL	-	STereoLithography
MMC	-	Maximum Material Condition
LMC	-	Least Material Condition
PD	-	The pitch diameter
N	-	Number of teeth on the gear
P	-	Diametric pitch (gear size)
Cpk	-	Process capability index
Rz	-	Surface roughness

CHAPTER 1
INTRODUCTION

1.1 Introduction to Reverse Engineering

Engineering is the application of designing, assembling and economics, social and maintaining products of system. There are two types of engineering, forward engineering and reverse engineering. Reverse engineering is the process of taking the desired result and working backwards to arrive at the initial conditions. In addition, by obtaining a geometric CAD model from 3D points acquired by scanning existing product is part of the reverse engineering process. The parts are measured to redrawn using CAD to enhance performance and availability of the product (Weir, 1996). Thus, the physical and material characteristic required for successful reproduction to developed technical data. Figure 1.1 shows a process flow of engineering.
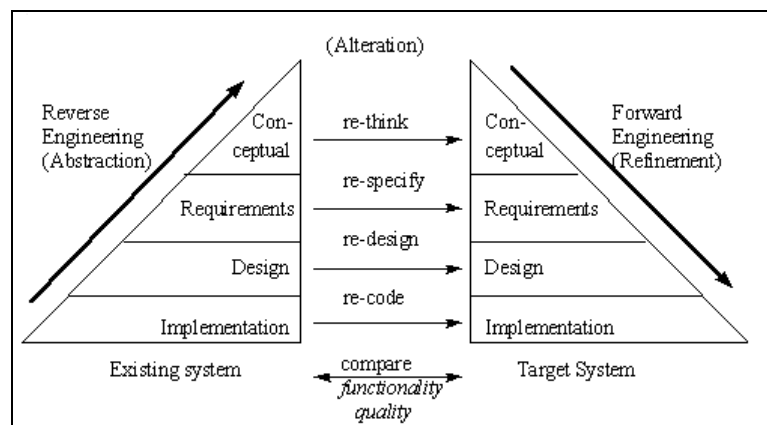

Figure1.1: Flow of engineering (Kotlyar, 1991)

1.2   Function of Reverse Engineering

Reverse engineering carries several benefits in order to make the equipment or machine last longer. The primary of reverse engineering is to maintain the product if the manufacturer no longer exits or no longer produces the product, but a customer needs the product. There are examples cases of this happen when the original product has become obsolete. In summation of that special function, reverse engineering is made to creating data to innovate or manufacture parts for which there are no cad data or data have become obsolete or lost. Furthermore, some bad features of a product need to be eliminated or reduce. Such as excessive wear might indicate where a product should be improved.

Henceforth, when analyzing the good and bad features of products, it can strengthen the good features of a product based on a long term usage. Reverse engineering enhance creating 3-D data from a model to create or scale artwork.

1.3   Gear in Reverse Engineering

Nowadays, on 21 century era, reverse engineering especially in automotive design field are developed and growth better to fits the needs of industrial specification without neglecting the characteristic of the product. Gearbox is a part of product that most important in automotive industry. Moreover, the criteria of the gear are dependent on the characteristic of the gearbox. The inspection of a gear is important to provide information for determining actual gear geometry characteristic (Kotlyar, 1991). There are 3 types of gears are widely used in reverse engineering. Which is parallel, intersecting and neither parallel nor intersecting.

1.3.1   Gear Connecting Parallel Shaft

Spur gears are used to transmit the motion between two parallel shafts. Helical gears are a cylindrical-shaped gear with helicoids teeth. These two gears are connecting parallel shaft.

1.3.2   Gear Connecting Intersecting Shaft

There are two types of gear connecting intersecting shaft which is straight bevel gears and spiral bevel gears. Straight bevel gear is to use in most applications, to transmit the motion between two perpendicular shafts. Meanwhile spiral bevel gears are essentially bevels gears with spiral teeth form.

1.3.3   Gear Connecting Non-parallel, Non-intersecting Shafts

There are two types of gear connecting non parallel and non-intersecting shafts. First are hypoid gears which this type is actually helical bevels gears mounted on two perpendicular shafts, but the axes of the shaft do not intersect. Second is worm gears which used to obtained a high speed reduction. The tooth of the worm is like ACME screw thread, whereas the mating gar is helical.

1.4 Problem Statement

Automotive industry currently has grown rapidly in this country. Parallel with this development, the demand for car's transmission system is high. In some cases, the original manufacturer no longer exits, but a customer needs the product, example aircraft spares required typically after an aircraft has been in service for several years. Besides, the original manufacturer of a product no longer produces the product, which is has become obsolete.

Various type of spur gear have been design and manufactured to fulfill the customer needs and the market value. Some of spur gear are not design with good quality forged because lack of quality production. In addition, customer no needs to deal with the supplier if the products are broken or damaged. With reverse engineering technique, the design documentation can obtained. Moreover, the CAD data can be manipulated in order to fabricate using different material or specification.

With obtaining the CAD data, the product is still not being able to produce. This is because lack of manufacturing information (Dimitrellou, 2008). Normally when some product wants to be manufactured, there are geometric, dimensional and tolerance must be considered. It is a main problem without GD&T on the drawing. When some product is going to reverse engineering there is a problem to determine an appropriate GD&T.

1.5 Objective

Based on the introduction and problem statement stated above, the objectives of this study are stated below:

1) To develop CAD data for spur gear component.
2) To produce 2D drawing that suit the standard of industrial specification

1.6 Scope

The scopes of this project are:

1) To do literature search on design and product development, Reverse Engineering and CAD
2) To carry out the bottom up approach of design activities
3) To identify an appropriate GD&T of the drawing

CHAPTER 2
LITERATURE REVIEW

2.1   An Overview of Reverse Engineering

According to (L.Wood, 2001) reverse engineering is a process that teaches engineering design to improve the repeatability design technique. By doing so, the skills are worthwhile, especially as design courses are moved in curricular. Reverse engineering also can be define as a duplicate a shape but broader a knowledge to involve understanding of design mechanism. Basically, conventional engineering transforms engineering concepts and models into real parts, in reverse engineering real parts are transform (Dixon, 1966) into engineering models and concept. These processes rely on the computational programing which is CAD/CAM in order to obtain the engineering models and concept. (Feng H.Y.Liu, 2001) Describe reverse engineering presented the effects of the scan depth and the projected angle on the digitizing accuracy of a laser/CMM scanning system.

(Paul, 2008) Stated that the main objective of reverse engineering system is to realize an intelligent 3D scanner. However, there is a long way to go. Even capturing shape and translating it into CAD model is a difficult and complex problem. In spite of several encouraging partial results in particular areas, a fully automatic solution to build a complete and consistent CAD model is still a goal. Figure 2.1 shows sequences to manufactures engineering product such as parts, moulds and tools.
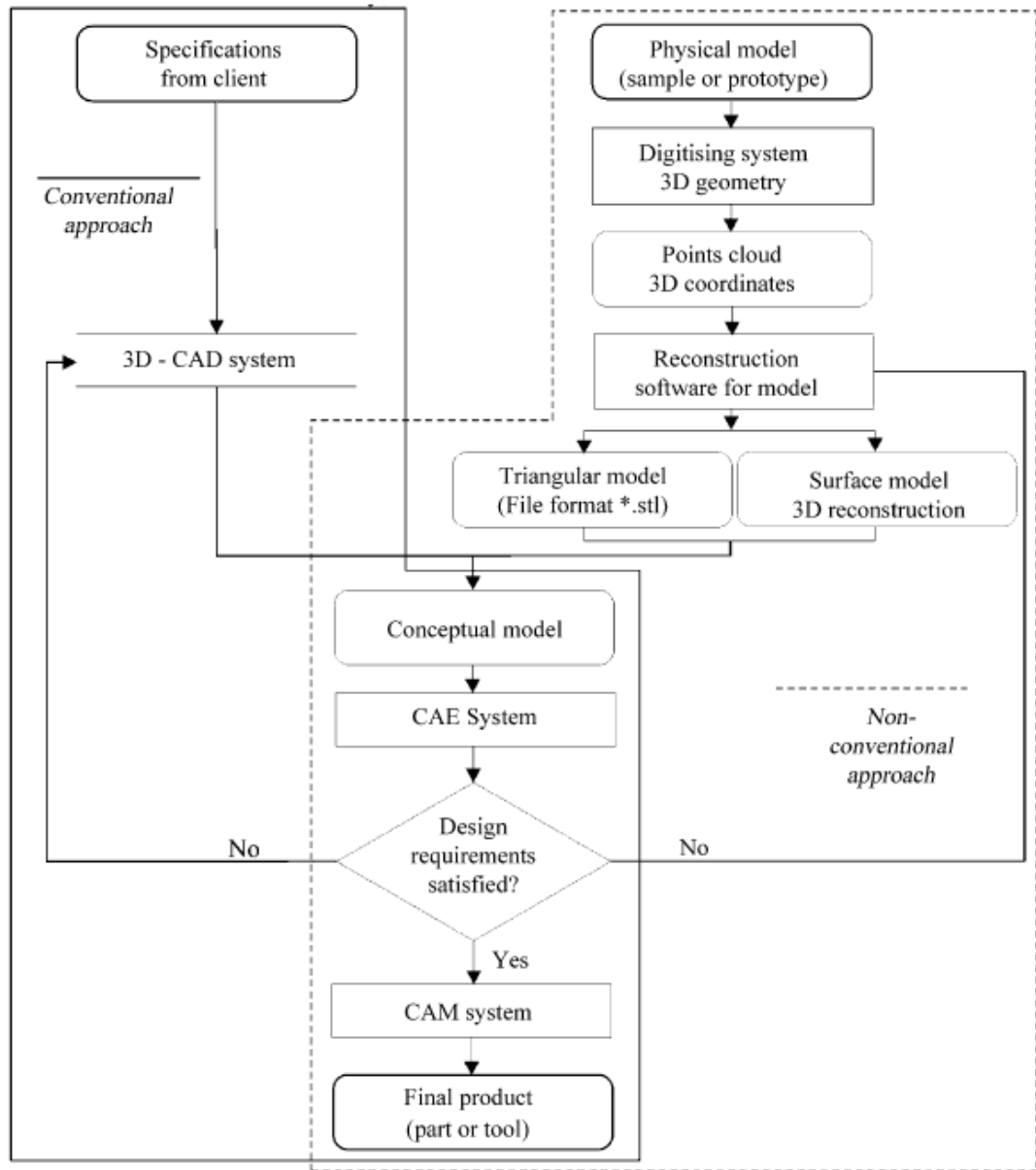
Figure 2.1: Sequences to manufactures engineering product (parts/moulds/tools)

(Kopac, 2005)

2.1.1 History of Reverse Engineering

Reverse engineering is the process discovering the technologies principle of a device, object or system through analysis of its structure function and operation (Eilam, 2005) . It often involves taking something apart and analyzing its working and details to be used in maintenance or to try to make a new device or program that does the same thing without using or simply duplicating the original. Reverse engineering technological innovation concept lets the very invention associated with an online version implementing details stored from a pre-existing problem. Researching right from sections which include appearance, computer graphic advanced manufacturing and even multimedia real truth has got covered near designing personal pc established statement belonging to the reliable circuit. In engineering application, all-inclusive reconstruction belonging to the piece variety is certainly required to replicate the problem whereas deviating on the mentioned areas by just not more than a predefined tolerance (Michael J Milroy, 1995). At this time, there are countless of reverse engineering innovation concept took advantage commercially based on a list of specifications and even rangers and even they are actually categorized into contact and non-contact.

2.1.2 Advantage of Reverse Engineering

Most of the time it is extremely difficult in order to obviously determine actual physical component geometry utilizing conventional dimension method. It is easy to see why digitizing has grown an indispensable product reverse engineering technological innovation progression. Reverse engineering quickly and accurately bridges the gap between poorly or undocumented tooling and fully modifiable 3D cad models useful for modern manufacturing method. The advantage of turn reverse engineering innovation is certainly shown.

a) manufactures can use modern molding technologies on legacy parts
b) produce records for any component wherever not one been around prior to or even records which is updated

c) quickly records the design intention of the component and minimize the quantity of amount of time in item style period

2.1.3 The Basic Principle of Reverse engineering

The reverse engineering progression will be divided in to 3 stages which happen to be digitizing, data segmentation and even details connecting. The reverse engineering objective would be to bring in a good conceptual model; experiences covering triangulated by a physical version a sample prototype. In this particular perception the particular 3D scanning (digitizing) strategies helped simply by customized application regarding design reconstruction attained. According to (Kopac, 2005) 3D scanning or digitizing will be the means of get together info from an undefined 3D surface area.

2.1.4 Classification of Different Approach of Reverse Engineering

According to (Singh, 2012) stated that in reverse engineering, Digitizing and collection of coordinates of every point of contact of probe with the part surface is the point cloud of the part or product. There are 2 types' approaches which is conventional approach and non-conventional approach.

2.1.4.1 Conventional Approach

The conventional method of create items along with CAD/CAE/CAM methods usually depends on the actual geometric modeling making use of the CAD program. The actual geometric product might be represented a cable framework or even because areas or even like a strong framework. Through conceptual modeling, the actual created CAD info might be released consequently within regular file format IGES points/STL binary, ASCII information, DXF polyline, VDA factors or even