"I hereby declared that I have read through this thesis and found that it has comply the partial fulfillment for awarding the Bachelor Degree of Mechanical Engineering (Design & Innovation)"

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Date : 9/5/2008

ANALYSIS OF DATA EXCHANGE IN CAD

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DECLARATION

I hereby declare that this project report entitled

ANALYSIS OF DATA EXCHANGE IN CAD

is written by me and is my own effort and that no part has been plagiarized without citations.

Signature : .....

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Date : 9/5/2008

DEDICATION

Dedicated to my beloved family Father (Mr. Khor Chun Hee), Mother (Mrs. Goay Ee Pheng), and also my friends which always be my side

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In here I would like to record my grateful thank to all the support, encouragement and inspirations I obtained through out the duration of this project.

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ABSTRAK

Projek ini mempersembahkan penukaran data CAD untuk permodelan CAD yang berbeza. Mesin RP digunakan untuk mengkaji kesan proses pembuatan apabila model CAD pepejal atau *Close Surface Model* dipindahkan kepada dasar penyelidikan pembangunan produk. Oleh itu, model ujian dicipta khas untuk tujuan penyelidikan projek dan perbandingan dibuat antara perbezaan CAD system software dan kesan terhadap model yang terhasil daripada mesin RP. Ianya bersangkut paut dengan data CAD dari segi geometri, struktur, topologi dan Perkembangan CAD. Di samping itu, proses penukaran data membolehkan data disimpan dan disemak pada tahap yang sama dan membolehkan tugasan serentak dilakukan. Penukaran software dapat memastikan data yang diperolehi dalam keadaan yang terbaik. Menyediakan RP model dan scan titik data dari sampel geometri atas permukaan model denggan menggunakan 3D scanner. Titik data tersebut boleh digunakan untuk membangunkan semula bentuk asal dan mejaminkan bentuk CAD data. Akhirnya, dapatan kajian daripada analisis data dan membaik puliahan peralatan adalah untuk memastikan CAD *Solid Model* atau *Surface model* dapat dipindahkan kepada dasar penyelidikan pembangunan dan *Solid Modeling* system lebih sesuai untuk digunakan oleh mesin RP.

ABSTRACT

This project presents an exchange CAD data between different CAD modeling systems. By RP machine is to study used how on the affect of the manufacturing process when CAD solid model or close surface model is transferred to product development research ground. So, a testing model is created for research purposes during this project. The different CAD system software was compared and investigates the affect model comes out from RP machine. It is related with CAD data in geometries, structures, topologies and the CAD extension. Beside that, the data exchange process enables data to be saved and viewed at the same standard and should allow more efficient concurrent working. Exchange software can ensure that CAD data is in the highest quality standard. Prepare the RP model and scan the point cloud of geometric samples on the surface of the model using 3D scanner. These points can then be used to extrapolate the shape of the subject and result of surface reconstruction procedure can guarantee the recovering CAD data model. Finally, the results from data analysis repair and fixing tools is achieved to ensure that the CAD solid model or close surface model is transferred to product development is perfectly and the solid modeling system more suitable for RP ready process.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

SYMBOLS	DEFINITION
mm	millimeter
mm^3	cubic milimeter
s	second

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

Computer-aided design, CAD is used to design, develop and optimize products. CAD is also widely used in the design of tools and machinery used in the manufacturing of components and in the drafting and designing of all types of machines, products and buildings. CAD is not only important in detailed engineering of 3D models and 2D drawings of physical components, it is also used throughout the engineering process from conceptual design and layout of products, through strength and dynamic analysis of assemblies of manufacturing methods of components. So, the CAD design can consider engineer to design the new product and sell it to market.

CAD data exchange involves a number of software technologies and methods to translate data from one CAD system to another CAD file format. Most of the systems can output CAD data from their systems without any problems, but problems also occur when the CAD detail is not good enough when the machine is use, particularly when dealing with imported data or surface based systems. We must produce a good data to ensure that in-house prototyping staff or service provider is working with the perfect data. CAD has become an important technology, within the scope of Computer Aided technologies, which provides lower product development costs and a shortened design cycle. CAD enables designers to present and develops work on screen, print it out and save it for future editing, which can save time when producing on the drawing.

The main analysis is the translation of geometry, wireframe, surface and solid model. Other important data such as attributes, metadata, assembly structure and feature data also are studied exchange CAD data is one of the most important elements of modern manufacturing practice. However, problems in CAD data exchange presenting one of the most alarming obstacles to productivity and time to market in manufacturing today. Geometrical and topological mistakes may occur during the design of a model. They remain undetected in the source system. But these mistakes are often the reasons for losses in the target system.

Data exchange between CAD systems is an extremely important solid modeling concept, both vital in the field theories and its practical applications. The two main data exchange paradigms are geometric and parametric data exchange. Geometric data exchange is the ordinary method, in which the boundary representation of the object is exchanged. Parametric data exchange is a novel method where, given a parametric history graph in a source system, the goal is to construct a graph in the target system that results same as geometry while keeping as much parametric information as possible. Each method has its uses and associated problems.

The aim of this project is to analyse data exchange in CAD and its effect to manufacturing. This project start with design of a testing model and compare it with three data exchange software and the result is used to solve the surface problem of the CAD model. For several reasons, it's often possible to achieve better results in exchanging CAD data between systems if the models are adequately prepared in the source system. Each CAD system offers certain possibilities for modeling and internal data representation which distinguishes them from other systems. These differences can lead to problems during the exchange of CAD data between the systems. One of examples is the accuracy changes between Rhinoceros CAD software to CATIA V5R10 CAD software. The different between these systems cause a lot of surface problem, because these two software are different in modeling system. There are several important roles should be considered for this project and they included:

a) CAD model in different extension.
b) CAD files in different modeling system.
c) CAD data using in RP machine.

1.2 Problem Statements

The standard data interface between CAD software and the RP machines is the STL file format. STL file approximates the shape of a part or assembly using triangular facets. Tiny facets produce a higher quality surface. There are a number of typical errors faced when exporting STL files. Firstly due to the polygon-mesh nature of the format, STL files are always an approximation of the 3D digital model. Basically, by reducing the size of each triangle in CAD software, the resolution of the model increases and the file size of CAD also increase. The problems with the resolution are most noticeable on non-planar geometry as this is represented as a facetted surface rather than the exact surface data within the CAD system.

There are several problem caused by STL files and they are due to the very nature of STL files as they contain no topological data. Many commercial tessellation algorithms used by CAD vendors today are also not robust, and as a result they tend to create polygonal approximation models which exhibit the following types of errors. Duplicate triangles in STL CAD model, flipped triangles in surface of CAD model, intersecting triangles, gaps between triangles, holes in surface of model, triangles sharing more than one edge, too many facets and more than one element are common problems in STL.

For preparation process in order to use RP machine, this will involve the slicing process in the STL file. For example, FDM machine have process of slicing the STL file according to layer thickness i.e. 0.17mm in minimum. These limitations can cause the problem such as stair-stepping. To avoid this problem, the CAD model must have smoother surface when export to STL extension.

Engineers over the world are well aware of the challenges of sharing CAD data with colleagues and business partners. Data exchange problems arise on a daily basis in design, analysis, simulation, manufacturing, and other countless applications. Competitive pressures among companies drives innovation and demands quality, as well as creating increasingly complex products that requires fast efficient sharing of product data.

1.3 Objectives

This project will be started with the goal of studying CAD data and it effects on manufacturing. It also will provide opportunity to learn on analysis of CAD model structure and RP machine. Other objectives are:

a) To design the testing model using CAD software.

b) To study the STL export problems.

c) To design CAD model STL viewer.

d) To correct the problem of data exchange by using data exchange software.

e) To analyses reverse engineering problems during CAD and RP process.

f) To improve CAD data and to suggest solution to the problems.

1.4 Scope of Project

1 **CAD data in terms of geometries, structures and topology.**

Geometrical data exchange through triangulated boundary models is the process to get the 3D CAD file using by 3D machine.

2 **Design Test Model.**

Three types of CAD software will be used to design the testing model. The software are AutoCAD 2004, CATIA V5R10 and Rhinoceros 3.0. The testing model of Tamiya small type toy's engine will be design such as figure below.

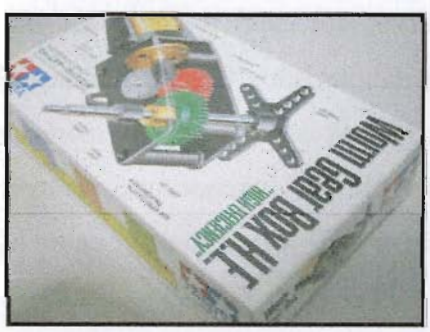

Figure 1.1 Tamiya Gear System.

Figure 1.2 Tamiya Gears

3 **Testing Model Create by Using RP Machine.**

Solid modeling or surface modeling will be used to create STL CAD model. Testing model will be created by using rapid prototyping FDM machine and ABS material to compare the result.

4 **The Manufactured Test Model.**

The process of surface reconstruction CAD model to RP machine and how the 3D scanner CAD data affect the manufacturing process will be studied when CAD solid model or closed surface model is transferred to production department.

1.5 Thesis Outline

This thesis is presented in different chapters. Chapter One introduced the basic theory, the encounter problem and the content of the thesis and also the thesis objective. Chapter Two consists of literature review on CAD, the STL extension and the introduction of RP machine and 3D scanner. In addition, this chapter also include the information of data exchange software and CAD modeling software. In Chapter Three, the project implementation from analyse and how to solve the crack model until the CAD file in good surfacing. Chapter Four will explain how the STL CAD data will undergo pre-processing, verifying, repairing, slicing, orientation. In Chapter exchange software problem face, the results from data analyse, repair and fixing tools to ensure that the CAD solid model or closed surface model is transferred to product department and it effect to manufacturing process. Chapter 5 will continue with the reverse engineering in 3D scanner and RP process. Discussion, recommendation and conclusion will be explained at the end of this report.

1.6 Summary

Today, in competitive business area, companies must continually work harder to create new and better products, faster and more efficient than their competitors. The design and manufacture process is continually enhanced to be more responsive to changes as well as quicker to market. So, there are many CAD environments available for creating new engineering designs or concepts. As new design or modification to a current design is developed in a package such as CATIA or AutoCAD, this model can then be created in a short time and able to produce an actual prototype for further testing or make the model by using rapid prototyping systems. Many RP developers are focusing their efforts in creating system software interfaces that are more familiar to users. In product design CAD data quality plays a major role in achieving the target date in the limited time for product life cycle development. To ensuring the quality of CAD data is necesseried for data to be used within the product development. A clean set of CAD model data saves time and money in mock-up using RP machine (FDM) and CNC machining. So, data exchange process enables data to be saved and viewed at the same standard and should allow more efficient concurrent working. Data exchange software can ensure that CAD data is at the highest quality standard.