UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN FLEXIBILITY STUDY FOR PRODUCT DEVELOPMENT USING DIRECT MODELING CAD SYSTEM

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

by

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: Design Flexibility Study for Product Development Using Direct Modeling CAD System

SESI PENGAJIAN: 2015/16 Semester 2

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

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ABSTRACT

A common CAD system must be provided a CAD data transfer that fulfils the need to satisfy each of these functions even in a different use of CAD data formats. In CAD system, it needs a compatible design tool to share all or part of product data that could be worked together. During the design process, a part of the product may go through with various field of design application such as Computer Aided Manufacturing, Finite Element Analysis, Kinematics or Dynamics Analysis, and Virtual Reality. In industry, manufacturers always look for a new model that having an interoperability CAD system which can improve part or product quality and minimize the rate of the production costs. Unfortunately, there are many problems regarding failure data translation or intelligent CAD data loss. Thus, a case study was carried out to identify the method of direct modeling in a CAD system. This software study (direct modeling technology) is used to solve the interest in interoperability issues which having product transformation of a sheet metal model to a plastic injection model. In this scope of the study, the CAD interoperability issues can be solved and handled through CAD conversion, geometric translation and its feature-based design in a CAD system. Three factors of technical information are carried out such as Ergonomic Review in CATIA software, Injection Mold Design Consideration in SolidWorks software, and Final Design Simulation in KeyShot for hand-dryers' design considerations. These results of the proof of concept shown direct modeling technology had compatibility with one another and solve the interoperability issues for CAD users. In general, the method of direct modeling can remove bottlenecks in the early design process by making amendments and additions in few of seconds, rather than having to wait for using the method of traditional modeling to rework the design. The direct modeling technology provides a design tool that having a very quickly iteration on design concepts, simply edits the actual CAD part geometry and common intermediate CAD data translation format for multi-disciplinary CAD systems used in manufacturing industries.

ABSTRAK

Sistem CAD menyediakan pemindahan data CAD yang memenuhi setiap fungsi malah penggunaan CAD format data yang berbeza. Dalam sistem CAD, ia memerlukan suatu alat rekabentuk yang sesuai untuk berkongsi semua atau bahagian data produk yang boleh berfungsi bersama-sama. Semasa proses rekabentuk, sebahagian daripada rekabentuk produk boleh dijalankan dalam pelbagai bidang aplikasi rekabentuk seperti Pembuatan Berbantukan Komputer, Analisis Unsur Terhingga, Analisis Dinamik atau Kinematik dan Realiti Maya. Dalam industri, pengilang sentiasa mencari model baru yang mempunyai sistem saling kendali CAD yang boleh meningkatkan kualiti bahagian atau produk dan meminimumkan kadar kos pengeluaran. Tetapi, terdapat banyak masalah tentang kegagalan penterjemahan data atau kehilangan data CAD pintar. Kajian perisian ini (teknologi pemodelan terus) digunakan untuk menyelesaikan isu-isu saling kendali yang mempunyai transformasi produk daripada model lembaran logam kepada model suntikan plastik. Isu-isu saling kendali CAD boleh diselesaikan dan dikendalikan dengan penukaran CAD, terjemahan geometri dan rekabentuk berasaskan ciri-ciri sistem CAD. Terdapat tiga faktor maklumat teknikal yang dijalankan seperti Kajian Ergonomik dalam perisian CATIA, Pertimbangan Rekabentuk Acuan Suntikan dalam perisian SolidWorks, dan Simulasi Rekabentuk Akhir di KeyShot untuk pertimbangan rekabentuk produk pengering tangan. Keputusan ini menunjukkan konsep teknologi pemodelan terus mempunyai keserasian antara satu sama lain dan menyelesaikan isu-isu saling kendali bagi pengguna CAD. Secara umumnya, kaedah pemodelan terus boleh menyinkirkan kejejalan dalam proses rekabentuk awal dengan membuat pindaan dan penambahan dalam beberapa saat, dan bukannya perlu menunggu untuk menggunakan kaedah pemodelan tradisional untuk kerja semula rekabentuk. Teknologi pemodelan terus menyediakan suatu alat rekabentuk yang mempunyai lelaran cepat pada konsep rekabentuk, semata-mata edit CAD bahagian geometri sebenar dan format terjemahan data pertengahan umum CAD untuk pelbagai disiplin sistem CAD yang digunakan dalam industri pembuatan.

DEDICATIONS

First and foremost, I would like to thank my parents for standing beside me throughout my education and further career, especially my dearest mother. She has been my motivation and inspiration for continuing to improve my mind knowledge and achieve my aim of career successfully. She is the one who I respect the most, and I would like to dedicate this for her. I also want to appreciate my dear sisters and brothers; they always understand me and support me even I was making a wrong decision in certain time. I really hope that there will be an opportunity to prove to my dearest one that my thinking is correct and their understanding why I spent so much time in education. I would like to thank my big family including my cousins; they have always given me suggestions and supported me throughout my part-time business. I really appreciate what they have done for me, especially my aunties and uncles. I am looking forward to discuss this part with my family in the future gathering and I am very sure they will witness my success in the coming convocation.

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LIST OF SYMBOLS AND ABBREVIATIONS

CAD	=	Computer Aided Design
CAM	=	Computer Aided Manufacturing
CAE	=	Computer Aided Engineering
CFD	=	Computational Fluid Dynamics
2D	=	Two-Dimensional
3D	=	Three-Dimensional
STEP	=	Standard for the Exchange of Product Model Data
STL	=	Stereo Lithography
IGES	=	Initial Graphic Exchange Specification
DXF	=	Drawing Exchange Format
SCDOC	=	SpaceClaim Document
NURBS	=	Non-Uniform Rational B-Spine
CNC	=	Computer-Numerical-Control

CHAPTER 1
INTRODUCTION

1.0 Introduction

Computer Aided Design (CAD) system is started around the mid-1970s to provide more efficiency than manual drafting with electronic drafting. Now, CAD systems are used to develop a geometric model of the product from the conceptual ideas. Especially for manufacturers, design product can be developed to include material and manufacturing information with a geometric model of a design. In CAD design system, an integral part that can be considered is the geometric modeling that can be built with a wire-frame model, surface model or solid model. But, most of the industries are related to the multi-disciplinary projects that involving a large of sharing data information among vendors for designing various parts of their end product.

1.1 Background

One CAD system in-house concept is usually being used in industry areas, due to the interoperability issues that they have to deliver or receive design by each of them. Even a design system combination, it has to contribute in a model data that need to deliver to manufacturers and suppliers by using CAD data conversion. Because of there are a lot of different types of data translation or data conversion, manufacturers are suggested to use common formats or neutral formats such as STEP, IGES, DXF, or Parasolid for minimizing the lack of any common set of data during compiling a neutral file exchange process. Meanwhile, a traditional system - Part-Product-Part is still being used by manufacturers, it does not give a well-perform job in a rise of such global efforts and high competitive markets. For this reason, they are facing a challenge to their industries especially the automotive,

aerospace, shipbuilding and locomotive manufacturers and their suppliers. It is worth to study the CAD interoperability issues for handling CAD conversion, geometric translation and its feature-based design in a CAD system.

1.2 Objective

The need for sharing information which involving in a multi-disciplinary project has been requested by manufacturers or suppliers, to choose a flexibility CAD system that can be developing a CAD model with quickly and efficiently. This concept is chosen as the CAD system developer because it represents an average CAD system which to access manufacturers and suppliers acceptance if such a CAD system. The purpose of this report is to identify the result of a state-of-the-art investigation of a 3D modeling CAD system product development. This report is including a demonstration of the practical side of its process.

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1.3 Scope

The main consideration in proposing a flexibility CAD system provided a CAD data transfer that fulfils the need to satisfy each of these functions even in a different uses of CAD data formats. The CAD system must have giving benefits such as quick action, easy to use, and acceptance by each of users. Other aspects like the function of CAD models and the CAD simulation analysis will not be covered in this project. The CAD system should be focus mainly by CAD to CAD users in developing and presenting their product development models.

1.4 Research Flow

The organization of this report is divided into five sections as following: Section 1 describes a short introduction to the CAD system problem currently. Section 2 determines the different concepts of engineering 3D model data is

delivered between manufacturers and suppliers. Section 3 discusses the flexibility design study for product development using direct modeling CAD system. A brief description of the direct conversion CAD data can be used in single part or fully parts combination of different type of formats. Section 4 presents the detailed parts assembly studies carried out for a sample bicycle assembly mode. An analysis of the performance of the different CAD system and an effective comparison between them is given. Conclusions and recommendations for the study are stated in section 5.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

This chapter will discuss mainly on the various knowledge of theoretical and experiences of experimental in Multiple-CAD System, CAD Interoperability, Overview of CAD/CAM/CAE, Data Translation Formats, Overview Injection Moulding, and Material for Injection Moulding.

2.1 Multiple-CAD System

This section describes the current situation how manufacturers to develop a model of product with existing various parts of different CAD data file. In a multi-CAD system, it holds a lot of CAD data file. The purpose of using multiple types of file is given a heavy data load can be distributed as many different files instead of having all information in one file. Because of many heavy industries like the automotive, aerospace, shipbuilding, heavy equipment manufacturer and their supplier are using multi-file types to handle the separate tasks required for modeling versus detailing simplifies the interaction between both tasks.

2.1.1 Ship Layout Design System

A joint-industry shipbuilding project was carried out since 2008 to 2011; its project name is called Innovero. In this project, a confederation of software agents was required to produce an infrastructure of ship design in a short producing time and design process. Now, there are having a range of applicable software that can be

used to develop a ship's infrastructure; Not only architectural analysis software can make it, even the general-purpose computer aided design system such as AutoCAD, Eagle, or Inventor also can be considered to build it. In fact, a large of components that creates part by part for the internal geometry of the ship including its representation and utilization. In the design stage, designers are not necessarily required to their design and functionality of a tool into a most suitable model. Because of the designers were thought about the design reconsideration and subsequently redesign for improvement purpose (Koningh, 2011).

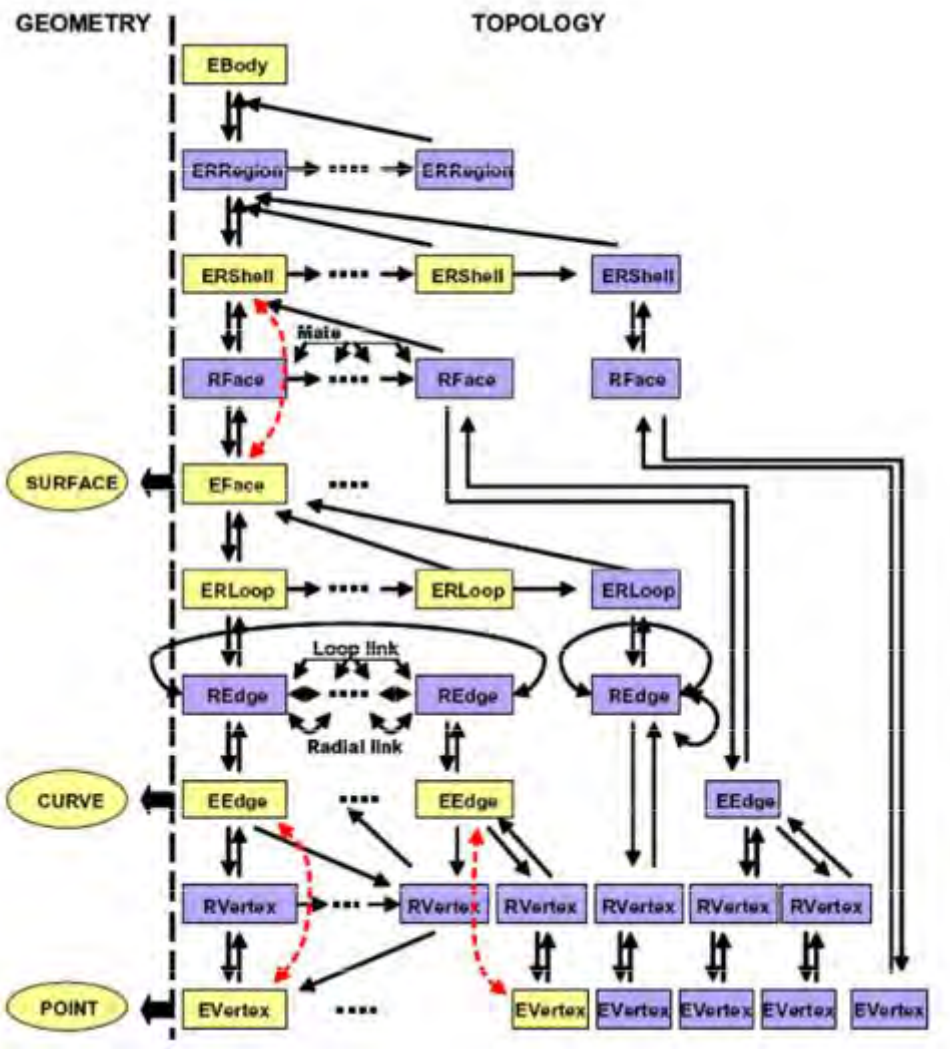

Figure 2.1: A Data Structure for Solid Models

(Source: Lee, 2009)

Several studies (Lee et al. 2009) have proposed a data structure based on a non-manifold solid model as Figure 2.1 given above. Each of the solid models, manifold and non-manifold, has their pros and cons. But, the multiple representation methods are used to apply on the ship layout design and its software system. The important thing is, designers should focus on the representation of the internal geometry of the ship. It likely rooms, spaces, holds or compartments are either modeled as volumetric entities or with the aid of bulkheads and decks or the mixed use of volumes and planes. There are various ship hull representations even different file types solid models (volume), surface models (plane), or wireframe model (plane). They need convert all different format files into a neutral file such as Standard for the Exchange of Product Model Data (STEP), Initial Graphic Exchange Specification (IGES), Stereo Lithography (STL) and other CAD data that can readable and can be applied in parts combination of a product model. Even having a neutral file as their standard rule for saving files, they offer higher chance given the greater possibility of interoperability issues to their CAD system.

2.1.2 Automotive Design System

A rise of the sharing data has happened to the top of the agenda for many industries especially in the field of automobile. One of the large automobile manufacturers in United State (U.S.) called General Motor (GM), and it has facilities in 30 countries. Due to there are many parts have to make for a car, they are sent to outside suppliers or agents to create the parts usually. The specification parts or products are always being prescribed by the GM. From this case, different business company has different CAD system that suits a verity of application. If the condition of a situation needs more than wants, the company was required to have two or more than two CAD or CAD/CAM system to achieve format standards' requirements. Although there is a great interest in understanding the conditions that supply chain of Business Company would not work due to it is a single CAD system and data incompatibility. On the other hand, people from industries are prefer having a flexibility CAD system for data sharing among the different parties of the design

team instead of purchasing extra CAD software or third-party data converter which is expensive (General Motors Co., n.d.).

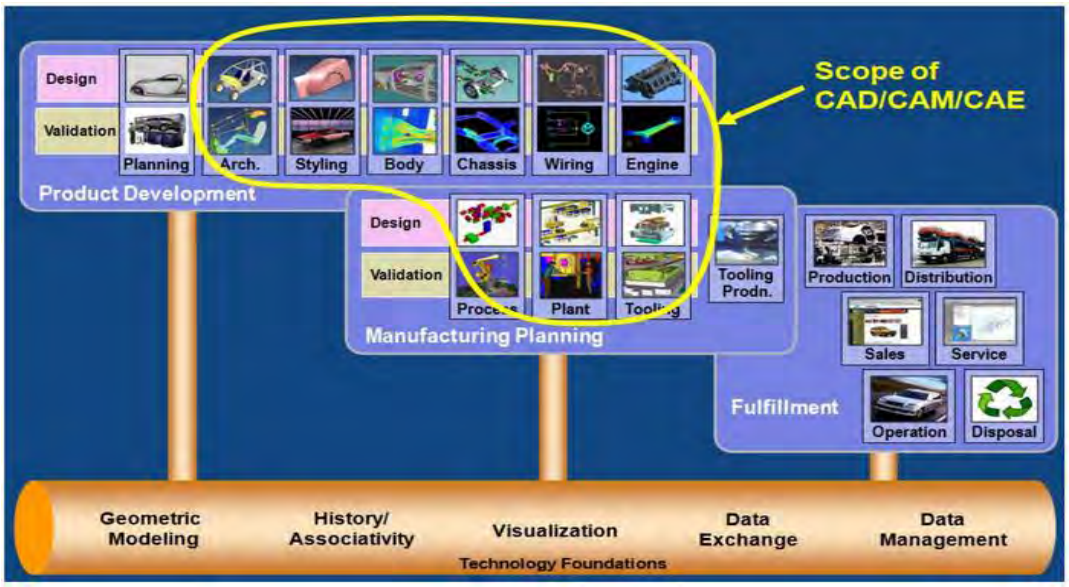

Figure 2.2: Siemens CAD/CAM/CAE Software for Automotive Industry (Source: Allen, n.d.)

An example of the literature review from Siemens CAD/CAM/CAE software shown that the automotive manufacturers are used their software technology apparatus. To develop the important parts of car or components likely car body, chassis, engine, architectural structure, styling frame, and wiring planning in the CAD system. The following Figure 2.2 shown as above, a general process flow of making a car started from the product development stage to the manufacturing planning and fulfilment stage. A way that designers that can predict and minimize the errors or problems of making a car; to ensure the final products can be exposure and good performance in the competitive markets. Unlike the customers, which focus mostly on the car performance and market price. The automotive manufacturers often have an intrinsic interest in the detailed specification for fulfilling customer demands and have been professionally successful in the field of automotive industry compared to the competitors.

Furthermore, one of the important basic technologies is the geometric modeling areas that manufacturers care about, the purpose of this surface modeling