NATIONAL TECHNICAL UNIVERSITY COLLEGE OF MALAYSIA

Automated Modification and Storage System in Computer Aided Design

Thesis submitted in accordance with the requirements of the National Technical University College of Malaysia for the Degree of Bachelor of Manufacturing Engineering (Honours) (Manufacturing Process)

By

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APPROVAL

This thesis submitted to the senate of KUTKM and has been accepted as fulfillment of the requirement for the degree of Bachelor of Manufacturing Engineering (Honours) (Manufacturing Process). The members of the supervisory committee are as follows:

....

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Abstract

This report presents the study that had been done on Computer Aided Design (CAD) system in order to create a simplified and automated system that can help in giving the possible easiest way for CAD user to modify CAD models and at the same time automatically save the CAD models into specified folders and directory. In order to create the system, extensive of research on the understanding of the capability of CAD system and Feature Based Modelling system is carried out. Several features in CAD models had been highlighted and studied. The methodology for the works done on this study has been listed out for the development of this automated parts modification and storage for CAD users.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURES

ASU	Arizona State University
B-rep	Boundary Representation
CAD	Computer Aided Drawing
CADD	Computer Aided Drawing/Drafting
CIM	Computer Integrated Manufacturing
CSG	Constructive Solid Geometry
CNC	Computer Numerical Control
FBM	Feature Based Modelling
FEG	Face Edge Graph
FREDS	Feature Based Rapid Engineering Design System
GCS	Global Coordinate System
IFBDS	Intelligent Featured Based Design System
LUT-FBDS	Loughborough University of Technology- Feature Based Design System
MCAD	Microsoft Certificate Application Developer
PCB	Printed Circuit Boards
PDF	Portable Document Format
QTC	Quick Turnaround Cell
WCS	World Coordinate System
VB	Visual Basic
VR-DIS	Virtual Reality – Design Information System

Chapter One

Introduction

1.0 Chapter Overview

This particular chapter give the glimpse or review of the work done in this thesis. The scope and objectives of this project are outlined and the contents of this work are briefly discussed.

1.1 The Need for Automated Modification and Storage System for CAD Models.

Feature-based technology can be divided into two areas; feature recognition and feature-based design. Feature recognition attempts to identify features from an internal representation or geometric model of a part after the design of the part's shape has been completed.

In contrast, feature-based design deals with the geometry of the features that can be automatically constructed by defining the features parametrically without requiring the user to translate the shapes of the component into geometric primitives. Some of the reported systems using feature-based design approach are QTC, LUT-FBDS (Case, 94b), FREDS (Wozny, 94), ASU Feature Testbed (Shah, 95), IFBDS (Gindy, 95). Nevertheless, most of the above feature-based designs have limitations in terms of automatically handling interactions between features.

The main goal of this research is to embed and developed an automated modification of feature- based modelling system into the existing CAD system to make it automatically interact with a CAD models and saved into specific storage folders in order to make it easy for CAD users.

Generally, this research rooted from the understanding of features of the designed products, and variable involved. In producing the intended system, this research heavily implemented numbers of computer tools and software including a computer aided system and certain programming language software.

1.2 Research Scope and Objectives

1.2.1 Research Scope

The scope of this research is to investigate ways and to develop an automated modification system that can automatically interact with CAD models and allow it to be saved into specified storage folders.

In order to achieve the desired system development, the deepest understanding of Feature Based Modelling, the application of CAD system, the implementation and assistance of programming language and the manipulation of existence case study is vitally needed.

1.2.2 Objectives

The objectives of the research are identified as below;

i. To understand Feature Based Modelling implementation and concept.
ii. To outline and apply the feature- based modelling within CAD models.
iii. To create a system that can automatically interacts with CAD models and being saved into specified storage folders.

Chapter Two

Literature Reviews

2.0 Chapter Overview

This chapter presents an all-embracing of literature review regarding the subject of CAD systems, Feature Based Modelling system, and programming language that will be further used and explained in this research. Various thoughts, work, and research on feature based particularly related to the design of products are explored. This chapter encompasses the definitions, characteristics, quantifications, discussions and modern computer applications of CAD system. It is intended that this chapter should give some clear literature background on the understanding of the concept of CAD systems, Feature Based modelling and its development in today's world of CAD system research.

2.1 Introduction to Computer Aided Design (CAD)

2.1.1 Definition

Computer Aided Design (CAD) is the technology concerned with the integrated design activities using a digital computer (Singh, 2000). Computer Aided Design (CAD) can be defined as the use of computer system to assist on the creation, modification, analysis, or optimisation of a design. Thus any computer program that embodies computer graphics and an application program facilitating engineering functions in the design process are classified as CAD software. The most basic role of CAD is to define the geometry of design- a mechanical part, architectural structure, electronic circuit, building layout, and so on- because the geometry of the design is essential to all the subsequent activities in the product cycle. The use of computer in the design of a product is to; increased the productivity of the designer and to create database for manufacturing.

According to Singh, (2000), engineering design has traditionally been accomplished on drawing. This process is iterative in nature and its time consuming. The computer can beneficially be used in the design process. In CAD, the design task is performed by CAD system rather than a single designer working over a drawing board. The various design related tasks which are performed by the CAD system can be group into four functional areas as below;

2.1.1.1 Geometric modelling

Geometric modelling is concerned with computer-compatible mathematical description of the geometry of an object. The mathematical description allows the image of the object to be displayed and manipulated on a graphics terminal through signals from the CPU of the CAD system. The software that provides geometric modelling capabilities must be designed for efficient use both by the computer and the human designer.

There are several different methods of representing the object in geometric modelling. The basic form use wire frames to represent the object. In this form, the object is displayed by interconnected lines. Wire frame geometric modelling is classified into three types;

a) 2D – two dimensional representations is used for a flat object.
b) 2½ D- this goes somewhat beyond the 2D capability by permitting a three-dimensional object to be represented as long as it has no side walls details.
c) 3D – this allows for full three-dimensional modelling of more complex geometry.

The most advanced method of geometric modelling is solid modelling in three dimensional. This method typically uses solid geometry shapes called primitives to construct the object.

2.1.1.2 Engineering analysis

In the formulation of nearly any engineering design project, some type of analysis is required. The analysis may involve stress-strain calculations, heat transfer computations, or the use of differential equations to describe the dynamic behaviour of the system being designed. The computer can be used to aid in this analysis work.

The analysis of mass properties is the analysis feature of a CAD system that has probably the widest application. It provides properties of a solid object being analysed, such as the surface area, weight, volume, centre of gravity and moment of inertia. For a plane surface (or a cross-section of a solid object) the corresponding computations include the perimeter, area and inertia properties.

Probably the most powerful analysis feature of a CAD is the finite element method. With this technique, the object is divided into a large number of finite elements (usually rectangular or triangular shapes) which form an interconnecting network of concentrated nodes. By using a computer with significant computational capabilities, the entire object can be analysed for stress-strain, heat transfer, and other characteristics by calculating the behaviour of each node. By determining the interrelating behaviour of all the nodes in the system, the behaviour of the entire object can be assessed.

Some CAD system has the capability to define automatically the nodes and the network structure for the given object. The user simply defines certain parameters for the finite-element model, and the CAD system proceeds with computations.

The output of the finite-element analysis is often best presented by the system in graphical format of CRT screen for easy visualization by the user. For example, in stress-strain analysis of an object, the output may be shown in the form of a deflected shape superimposed over the unstressed object. Colour graphics can also be used to accentuate the comparison before and after the deflection of the object.

Checking the accuracy of the design can be accomplished conveniently on the graphics terminal. Semiautomatic dimensioning and tolerancing routines which assigned size specifications to the surfaces indicated by the user, help in reducing the possibility of dimensioning errors. The designer can zoom in on part design details and magnify the image on the graphics screen for close scrutiny.

2.1.1.3 Design review and evaluation

A procedure called layering is often helpful in design review. For example, a good application of layering involves over-layering the geometric image of the final shape of the machined part on top of the image of the rough casting. This ensures that sufficient material is available on the casting to accomplish the final machined dimensions. This procedure can be performed in stages to check each successive step in the processing of the part.

Another related procedure for design review is interference checking. This involves the analysis of an assembled structure in which there is a risk that the components of the assembly may occupy the same space. This risk occurs in the design of large chemical plants, air-separation cold boxes, and another complicated piping structure.

One of the most interesting evaluation features available on some computer-aided design systems kinematics. The available kinematics packages provide the capability to animate the motion of simple designed mechanisms such as hinged components and linkages. This capability enhances the designer's visualization of the operation of the mechanism and helps to ensures against interference with other components. Without graphical kinematics on a CAD system, designers must often resort to the use of pin-and cardboard models to represent the mechanism.

2.1.1.4 Automated drafting

Automated drafting involves the creation of hard-copy engineering drawings directly from the CAD data base. In some early computer aided design departments, automation of the drafting represented the principal justification for investing in the CAD system. Indeed, CAD systems can increase productivity in the drafting function by roughly five times over manual drafting.

Some of the graphics features of the computer-aided design systems lend themselves especially well to the drafting process. These features include automatic dimensioning, generation of cross-hatched areas, scaling of the drawing, and the capability to develop sectional views and enlarged views of particular part details and also the ability to rotate the part or to perform other transformations of the image (e.g. oblique, isometric, or perspective views).

2.1.2 Methodology of CAD

In CAD, a sequence of events unfolds in a logical order, forming a design pattern which is common to all projects. This logical arrangement can be presented as a flow chart as shown in Figure 2.0. (Singh, 2000)

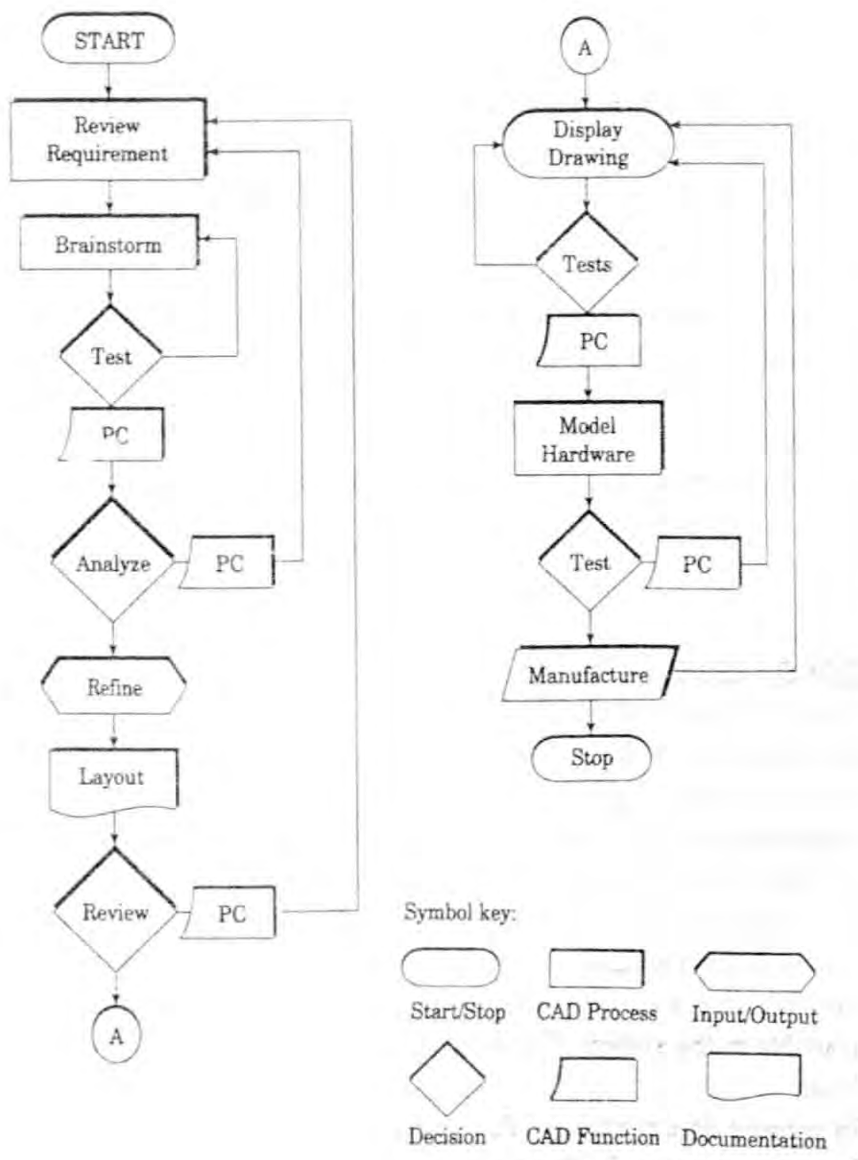

Figure 2.1- Flow Diagram of CAD methodology

2.1.3 Uses of CAD

Singh, (2000) has listed down some of the uses of CAD, as below:

1. To create conceptual product models.
2. Editing the model to improve aesthetics, ergonomics and performances.
3. Displays the product in several colours to select colour combination most appealing to the customers.
4. Rotate and view the objects from various sides and directions.
5. Create and display all inner details of assembly.
6. Check for interference or clearance between mating parts in static and/or in dynamic situations.
7. Observe functional aspects of relative movements of various elements or assemblies.
8. Analyse stress, static deflection and dynamic behaviour for different mechanical and thermal loading configurations and carry out quickly any necessary design modifications to rectify deficiencies in design.
9. Study the product from various aspects such as material requirements, cost, value engineering, manufacturing processes, standardization, simplification, variety reduction, service life, lubrication, servicing and maintenance aspects, etc.
10. Prepare detailed component drawings giving full details of dimensions, tolerances, surface finish requirements, functional specifications, etc.
11. Prepare assembly drawings depicting the orientation of components, assembly procedures and requirements, and in corporation of any additional details such as hydraulic or electrical connections.
12. Prepare exploded views of the assemblies for services and maintenance manuals.
13. Plot or print the picture/ drawing stored in a computer file.
14. Store the database for modification on a later date or manufacture.