



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

COMPUTER AIDED MOULD DESIGN

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By

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APPROVAL

This thesis submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design). The members of the supervisory committee are as follow:

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En Shajahan B. Maidin

Main Supervisor

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ABSTRACT

This project is named **Computer Aided Mould Design**. Nowadays, there are a lot of CAD software available in the market; SolidWorks is one of the CAD software which is selected in accomplishing this project. The purpose of using CAD is to help smoothen and quicken the design stage. In this competitive market, lead time becomes shorter and shorter while a lot of modifications may have to be done in order to meet the market challenges and needs. Thus, CAD is the common tool which assisting the design engineers. This project studies on the parameters of the mould components in terms of controlling it easily and quickly without repeating some of the design steps. *Design Table* is the function of SolidWorks which can be used to control the mould components' parameters by using Microsoft Excel worksheet. It is simple and convenient. Furthermore, all the information of the product can be stated clearly in the design table as references. Besides, drawings with design table and BOM are also the important details which is needed. Correction can be done any time if necessary with compromise of each party involved. Therefore, the collaboration between design engineers and toolmakers become more effective as the information can flow correctly in a very short time.

ABSTRAK

Projek ini bertajuk **Rekabentuk Acuan Berpandu Komputer**. Pada masa kini, pelbagai perisian rekabentuk berpandu komputer (CAD) tersedia dalam pasaran; *SolidWorks* merupakan salah satu perisian yang dipilih untuk mencapai projek ini. Tujuan menggunakan *CAD* adalah untuk menyenangkan dan mempercepatkan peringkat rekabentuk. Di dalam pasaran yang bersaing ini, tempoh masa yang diberi menjadi semakin singkat, manakala pelbagai pembedahan seringkali perlu dilakukan supaya menepati cabaran dan kehendak pasaran dari semasa ke semasa. Maka, *CAD* menjadi satu perkakas yang umum untuk membantu jurutera rekabentuk. Projek ini mengkaji parameter untuk komponen-komponen acuan dari segi pengawalan kepadanya dengan senang dan cepat tanpa mengulang semula sesetengah peringkat rekabentuk. Jadual Rekabentuk (Design Table) merupakan fungsi *SolidWorks* yang membolehkan pengawalan parameter komponen-komponen acuan dengan menggunakan *Microsoft Excel*. Cara ini adalah mudah dan senang. Di samping itu, segala maklumat penting yang berkaitan produk tersebut dapat disenaraikan dalam *design table* sebagai rujukan. Selain itu, lukisan-lukisan yang mengandungi *design table* dan *bill of material (BOM)* juga merupakan maklumat-maklumat penting yang diperlukan. Pembedahan boleh dibuat pada bila-bila masa dengan persetujuan di antara semua pihak yang terlibat. Maka, kerjasama di antara jurutera rekabentuk dan tukang peralatan (toolmaker) menjadi lebih berkesan kerana maklumat-maklumat yang tepat boleh disampaikan pada jangkamasa yang pantas.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

CAD	-	Computer-Aided Design
CNC	-	Computer Numerical Control
KBS	-	Knowledge-Based System
2D	-	Two Dimension
3D	-	Three Dimension
API	-	Application Programming Interface
COM	-	Component Object Model
OLE	-	Object Linking and Embedding
BOM	-	Bill of Material
EDM	-	Electrical Discharge Machining
EDNC	-	Electrical Discharge Numerical Control
BOM	-	Bill of Material

CHAPTER 1

INTRODUCTION

1.1 Background

Technology grows rapidly day by day and its contribution to mankind is tremendous especially in industry. Plastic injection moulding is one of the most important polymer processing operations in the plastic industry today. In conjunction with this, mould making is an important supporting industry due to its related products represents more than 70% among the components in consumer products [8]. The high demand for shorter design and manufacturing lead times, good dimensionality and overall quality, and rapid design changes has become the bottlenecks in mould industries [8].

Today, as time-to-market for plastic parts is becoming shorter, it is essential to produce the injection mould in a short time which is compliance with the customer requirement. According to L. Kong et al [9], conventionally, to proficient the mould design, requiring years of experience. Mould design is considered as a “mystified” art, less and less people are benefiting from experience and knowledge of the experts in this field due to the initial difficulty in learning it.

Thus, using computer-aided design (CAD) systems is a way to change the current situation. CAD systems have become smarter through embedding expert knowledge and linking with specialist engineering solutions. This trend will continue as more powerful expert systems are developed for engineering design and verification.

This project uses SolidWorks; a CAD software to control parameters of mould components from a simple worksheet, namely *Design Table*. The output will be a demonstration of the use of parametric CAD in the design of the injection mould components. Besides, this project also study in designing mould halves by using design table where the ease of interchangeability helps to save a lot of time.

1.2 Objectives

- (i) To use CAD in designing mould quickly and effectively.
- (ii) To allow interchangeability of parameters by using design table.
- (iii) To generate BOM (Bill of Material) for the mould components.
- (iv) To smoothen and quicken the collaboration between design engineers and toolmaker.

1.3 Scope

This project focuses on the interchangeability between the injection mould components. The components of the mould base will be identified accordingly. Different mould design may require different size of mould base. Therefore, this project aims to control or correct the design parameters of the mould base effectively and quickly. By optimizing CAD modeling software, SolidWorks is chosen to accomplish this project due to its powerful functionality in building ‘intelligence’ by using design table which in collaboration with Microsoft Excel. Since the time-to-market for plastic products is becoming shorter, timesaving is a crucial concern. Therefore, this project also target to smoothen and quicken the collaboration between design engineers and toolmakers in terms of flowing the correct information (design table, drawing, BOM) in order to meet the tight schedule on time.

1.4 Problem Statements

Injection Mould Base consists of many components which is complex. Designing mould base is generally the critical path of new design development. The lack of communication of people performing this activity results in long mould development time and incompatibility problems within injection-moulding industry. However, many of the features are driven by simple engineering rules. CAD modeling software is a relatively easy and convenient method in doing this. SolidWorks is one of the CAD modeling software which provides solid modeling tool with parametric functionality. It is possible to control parameters in SolidWorks models from a simple spreadsheet, namely *Design Table* which in collaboration with Microsoft Excel.

CHAPTER 2

LITERATURE REVIEW

2.1 Development of an Integrated Knowledge-based System for Mould-base Design

Z. Lou et al [1] have carried an industry-case study of mould factory in China. According to the paper, generally, the design stages of mould are detailed design of the mould; design of the mould base and ordering the mould base from vendors/ other sources; and manufacturing mould. In order to improve mould design efficiency and shorten the design time, a new design method is proposed. At first, the engineer designs mould base based on the dimension of the product. Next, the engineer starts to design the detail of the mould, while ordering the mould base from vendors. After completing both tasks, the mould can be produced by CNC.

In the paper, a data flow of the mould base design process is constructed (Figure 2.1). In this diagram, the designer is treated as an operator of the process and the output as a printer or other types of output-device. The case library stores successful mould design cases for case based reasoning. The circles are function modules and the lines are the data flows in the mould base design, the later being divided into the following steps:

- (a) *Cavity calculation*: calculating the shrink ratio in the part and the part's profile.
- (b) *Set-in calculation*: calculating the dimensions of set-in and other factors for set-in.

- (c) *Slide calculation*: considering the dimensions of the mold-base for the slide subsystem.
- (d) *Reason in cavity and core plate*: determining the dimensions of the plate's intention and rigid check.
- (e) *Calculating the number of plates*: determining the numbers of the plates in the mold-base based on the gate and product information.
- (f) *Reason mold-base*: creating the mold-base model based on the information above.
- (g) *Mold-base check*: checking the interference of additional structures (spring, ejector pin)
- (h) *Injection machine choice*: checking the installation method and interference between the mold-base and the machine.

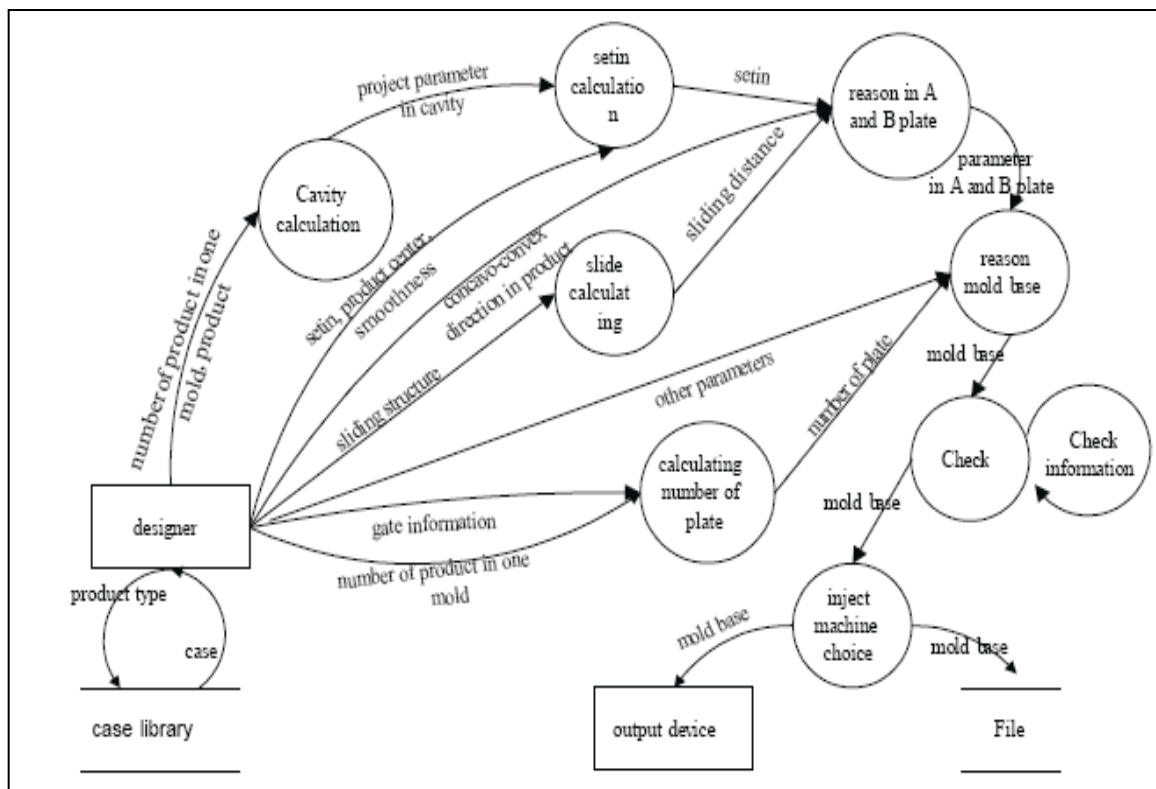


Figure 2.1: The data flow diagram in the mould base design [1]

Referring to Figure 2.2, KBS (knowledge-based system) is defined as a type of software built on the product model that is able to store and process the knowledge relevant to the product model, including the product’s design, analysis and manufacturing methods. It is based on the Pro-Engineer 2000 Toolkit (PTC Corporation), which can execute mould base design such as set-in design, interference check, selecting the model of the mould base and other components. Besides, its field knowledge has four type of representation methods which are frame-rule (gate design), neural network (set-in and plate dimension calculation), case (mould base design examples and standard types), and mathematical calculation (interference checking in mould). In short, the key technologies in the KBS including product modeling, knowledge representation with a frame-rule structure, neural networks and case-based reasoning.

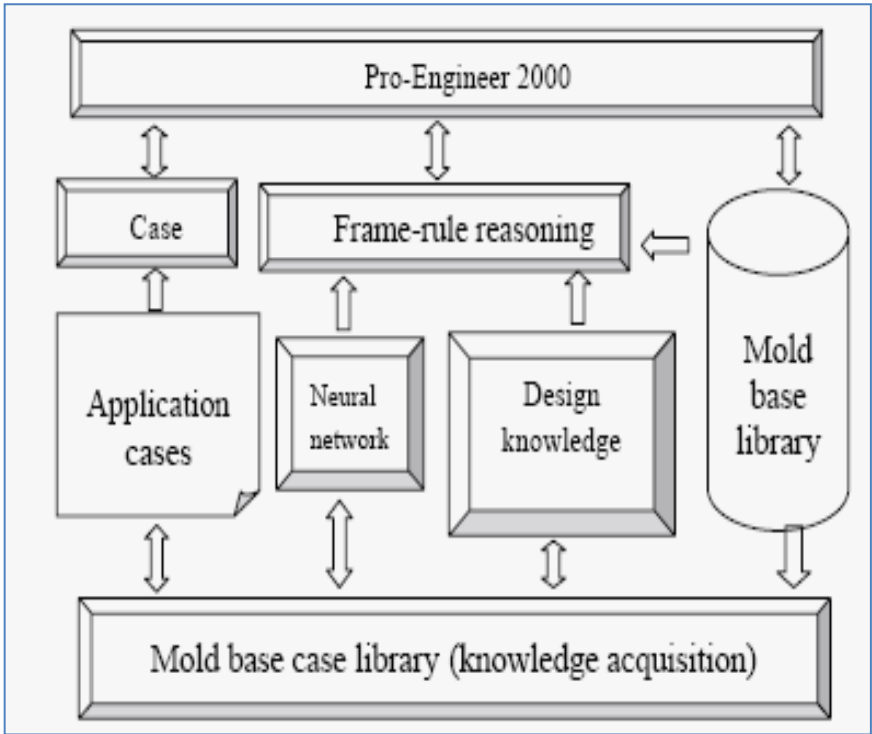


Figure 2.2: The mould base KBS [1]

2.2 Parametric-Controlled Cavity Layout by Using CAD

M. L H. Low and K. S. Lee [2] present a methodology for designing the cavity layout for plastic injection moulds by controlling the geometrical parameters using standardization template. The standardization template for the cavity layout design consists of configurations for the possible layouts. Each configuration has its own design table of all the related parameters. In order to ensure that the required configuration can be loaded into the mould assembly without redesigning, the standardization template is pre-defined at the layout design level of the mould assembly design. The method is closely related to this project as the mould base design will need to be standardized for potential timesaving. Besides, it is useful in technical discussion between toolmaker and customer before proceeding to manufacturing mould. Besides, changes can be made to the 3D model (layout cavity, mould base etc) immediately during discussion. Mould making company can also customize the standardization easily in order to meet their own standards.

According to L. Kong et al [4], the flexibility and advancement of Windows-native/ NT has made the chance for software developers create applications that are affordable and easy to use. SolidWorks is one of the mid-range solid modeler which was chosen as the platform due to the Windows-native design environment, powerful assembly capabilities, ease-of-use, rapid learning curve and affordable price.

2.3 Computer-Aided Design (CAD)

Computer Aided Design (CAD) applies to all aspects of design using computer software tools. It usually covers geometry creation, manipulation and the production of plotted drawings. CAD differs from bitmap graphics by defining a drawing as a collection of objects and coordinates rather than encoding an image as specific pixel values in a raster. The object definitions are stored internally in a database [3]. CAD requires software to plot the drawing from the coordinates and object definitions either

to a computer screen or to a printer/plotter or to create the objects in solid materials by driving manufacturing machinery. A major consequence of this is that images may be viewed and printed at any scale.

L. Kong et al [4] mention, at present, most CAD system provides only the geometric modeling functions that facilitate the drafting operations of the mould design. However, it does not assist mould designer with the necessary knowledge to design the moulds. Therefore, much “add-on” software has been developed on high-level 3D modeling platforms to facilitate the mould design processes. The 3D software modeling platform offers plug-in software with a library of functions as well as an established user interface and style of programming. As a result, the development time for these “add-ons” is significantly reduced.

2.4 SolidWorks

SolidWorks mechanical design automation software is a feature-based, parametric solid modeling design tool which takes advantage of the easy learn Windows™ graphical user interface. Creating fully associative 3D solid models with or without constraints while utilizing automation or user defined relations to capture design intent [5].

2.4.1 Feature-based

As an assembly is made up of a number of individual piece parts, a SolidWorks model is also made up of individual constituent elements. These elements are called features. When creating a model using the SolidWorks software, user work with intelligent, easy to understand geometric features such as bosses, cuts, holes, ribs, fillets, chamfers, and draft. As the features are created, they are applied directly to the work piece. Features can be categorized as either sketched or applied. Sketched Features is based on a 2D sketch. Normally, the sketch is transformed into solid by extrusion,