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A Wax Injection Mould Design System

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Abstract

Today, the time to market for metal casting products is becoming shorter, thus the lead time available for making the wax injection mould is decreasing. There is potential for timesaving in the mould design stage. This paper presents the basic structure of an interactive knowledge based wax injection mould design system. The basic of this system arises from an analysis of the wax injection mould design process for mould design companies. This wax injection mould design system covers both the mould design process and mould base standardization. In this system, the graphic module and the knowledge based module for generating mould features are integrated within an interactive Mold Wizard platform, Unigraphics system. This ensures that both speeds up the wax injection mould design process, without the need to redesign the mould base layout. With this capability, metal casting product could be designed quickly, cheaply with quality and competitively.

Keywords *: Wax Injection Mould, Standardisation Template, Mould Wizard Unigraphics*

1.0 Introduction

Today, mold design is a key aspect of the design process which requires knowledge, expertise and most importantly experience in the field. On the other hand, the design process of the mold still practiced on a "trial-and-error" approach. However, the method is recognized to be cost consuming and requires a lot of design process time. So, the manufacturer desire to shorten both design and manufacturing lead times through automating the design process.

For very limited production and in the development of procedures for high production, patterns for investment molding can be machined from expendable material, usually plastic such as polystyrene. When a large number of casting parts are required, the patterns are produced by injecting the expendable wax into cast or machined pattern molding dies. The dimensional tolerances of these dies are closely controlled. The injection mold design is critically important to product quality and efficient product processing. Mold-making companies, who wish to maintain the competitive edge, desire to shorten both design and manufacturing lead times by automating the design process. Thus, the development of computer-aided injection mold design system (CAIMDS) is becoming a focus of research in both industry and academia. Normally, designing wax injection mold is difficult due to inconsistency introduced by lack of experience of the designer. Frequently, design engineers with less experience consumes lot of time that directly increase the designing cost. Hence a method to improve the design process on wax injection mold needs to be researched. The objective of the research work is to develop a variety of mold base feature system and integrate them with Rapid Prototyping technology. This then can be used for testing and verification work.

2.0 Literature Review

W.M.Chan. et. al. (2003) discussed about 3D CAD knowledge-based assisted injection mold design system. The discussion is about the basic structure of an interactive knowledge-based system for plastic injection mold base (IKB-MOULD). The basic of this system arises from an analysis of the injection mold design process for mold design companies. This injection

mold design system covers both the mold design process and mold knowledge management.

The application of computer technology offers the potential to reduce product cycle time through computer-aided design (CAD) applications. This application has been discussed by John S. Tu et.al. (1995). For this study, the approach is by creating the finite-element mesh of the mold from the surface of the finite-element mesh of the metal, thus eliminating the extra effort of creating a CAD geometry of the shell.

Jagannath Yammada et. al (2002) described about the development of an intelligent mold design tool. The tool captures knowledge about the mold design process and represents the knowledge in a logical fashion. The knowledge acquired will be deterministic and non-deterministic information about the mold design process. Once developed the mold design tool will guide the user in selecting an appropriate mold for his plastic part based on various client specifications.

3.0 Current Practices In Producing Wax Injection Mold

Michael Chang from Caddcam Services Sdn. Bhd., the Technical Director for the mold maker company has explained and discussed about the mold design process and critical criteria of a wax injection mold. In general, the work process is shown as Figure 1. The mold maker will receive the orders from customers by either in drawing or product. After that, the designer will draw the 2D drawing of the mold base using CAD/CAM software (Vero Visi). Then, they will double check the dimensions of the drawing. If there is no error, the designer will create the 3D drawing. After that, the CAD/CAM software will generate the CNC part programming to run the machining. After machining, the mold dimensions will be checked before they are send to the customer. The customer will try to test the mold by injecting the wax or plastic into the mold. If there are any defects or not satisfied with the pattern produced, the customer will send back to the mold maker company to do the modification and improvement. The mold design process generally can be explained as shown in Figure 2. Commonly the wax injection mold is made by aluminum because aluminum is light and rustless. The mold should not be too heavy because the wax injection is operated manually. Mold base size depend on the pattern. Most of the design parameters are based on experience to design wax injection mold.

5.0 System Development

The system development can divided to four major parts. They are (a) be draw the standard mold, (b) create image file, (c) create excel file, and (d) register new catalog. The 2D sketch is used to create two dimensional representations of profiles associated with the part. The shape and size of the cavity and core is created using the 2D sketch. The middle of the wax injection mold have to be created at the Absolute CSYS (0,0,0) because the core and cavity will be inserted automatically base on this coordinate. The dimensional mode in the Constraints dialog is applied to the sketch objects. For the study only horizontal and vertical dimensions commands are used. When creating a dimensional constraint, an expression is created, and its name and value are displayed in the Current Expression text fields in the Constraints dialog. Then the expression can be edited. The 2D sketch has to be extruded to be solid using hybrid modeling. After that, use the commands in the modeling application to create a complete upper and lower mold. All the drawing have to be positioned based on the upper and lower mold that extruded from the 2D sketch to make sure the middle of mold will stay at the Absolute CSYS (0,0,0). The mold have been completely created in the 2D sketch and modeling application. After that, expressions are needed to control the characteristics of the components because expressions can define and control dimensions of the mold feature. The original expressions that were automatically created when generating the drawing need to be renamed and edited. The modification is to change the expressions name to more understanding words and simplify the expressions. That means the user needs to insert too much parameter when they want to change the value of the mold parts because the value of some parts will automatically be updated according to the expressions, this file can be refered later. Lastly, save all the files. The parts file need

to save in a strategic location for easy loading and more systematic.

The second part is creating the image file. The bitmap file is used to display in the moldbase management dialog. To create the bitmap file, first separate the upper and lower mold by deleting one part of the mold such as delete the lower mold. Now in the drawing, there is only the upper mold. Select the bottom view to get the clear view of the upper mold. After that, press 'Prt Scr' in the keyboard to copy the image of upper mold. Then use 'paste' command to paste at the 'Paint' application which can be found in the Microsoft Windows (Programs-Accessories- Paint). In the 'Paint' application use the 'Select' option to select the wanted part and save it. For creating the lower mold part image, the procedures are same as creating the upper mold image. The next step is to call out both images to join as one image file. Then, give the name (same as the name in the expressions) to the important parts. Finally, save the bitmap file in 'bitmap' folder.

The new catalog needs to register to the Mold Wizard application. After registering, the Mold Wizard will able to identify and read the data that is inserted by the user. The first step is open 'moldbase_reg_in' file in the 'english' folder. This is an excel file. Create a new work sheet in the excel file with a new name. The registering of the new catalog is not complete although the new work sheet has added to the 'moldbase_reg_in' file. The 'mold_wizard_catalog' file needs to edit to complete the registration catalog. Select and open the 'mold_wizard_catalog' in the 'english' folder. Name and location of 'moldbase_reg_in' excel file are insert into the 'mold_wizard_catalog' file. Finally, save the file.

Excel file need to be created to program the drawing of mold base. This excel file will link to the mold wizard. So the new mold base could be added to the drawing when using the mold wizard option in Unigraphics. First open a new excel work sheet. Then insert the name of work sheet in the first row starting with ##. These is followed by insert the sheet type, attributes and parameters. The standard parts need to be created to support the wax injection mold base. The procedures to draw, modify expressions and create bitmap file of the standard part is almost same as the procedures to create mold drawing. After that, just use the 'Register standard parts' application in the Mold Wizard.

6.0 Implementation and Analysis

The overview steps of the implementation are shows in Figure 3. The mold base system must be operated under Mold Wizard application environment. Therefore, before starting the implementation, make sure Mold Wizard and modeling applications are being selected in the Unigraphics. After that, a solid product drawing is needed to start the application. When all the requirement applications have been active, the design process can be started according to the steps that show in Figure 4.

Loading a product and project initialization is the first step in the mold design process. This option is to let the user load the product pattern from files that want to create in the core and cavity of a wax injection mold. Mold CSYS transforms a product assembly into mold orientation. It is product specific. This option is a very important because it will determine the parting line of the pattern that divide to core and cavity sides. Create family members in any convenient orientation, and then adjust each member product to match the mold base. After defining the orientation of the product in a mold cavity, the next step is to choose a method for placing the cavity or cavities within the mold. The Work Piece Dimensions dialog is used to define the type and size of work piece inserts that will be used to form the cavity and core. Work Piece selections include a Standard Block and combinations of independently modeled user defined bodies. Layout defines how many cavities the mold will contain and how they will be oriented in the mold. The Mold Tools icon activates the Mold Tools toolbar. From this toolbar user may access a variety of Mold Wizard and Unigraphics NX functions. The Mold Wizard tools are used in close conjunction with Parting Functions to complete parting designs. The Product Design Advisor (PDA) functions help user analyze a product model and prepare it for cavity and core parting. Parting is the process of creating a core and cavity based on a wax part model. The Parting Functions provide tools to assists in performing parting functions quickly. This option is a critical point because the parting line will determine the way of the mold open. So, if the parting line is inaccurate, the products that produced

by the mold will not been satisfied. Mold Base Management offers several standard moldbase catalogs and a few versatile interchangeable styles. A catalog for Wax Injection Mold Base has been added for the study. This is to facilitate the user when coming to design a wax injection mold base. For the Standard Parts Management, a new catalog also has been added to combine with the catalog of Wax Injection Mold Base in the Mold Base Management to make sure a complete wax injection mold base could be design without error. Wax molds have flow pathways that direct the wax to the mold cavities. The designs of these pathways vary depending on part shape, size, and number of parts to be molded. The most common type of pathway is called a "cold runner". Cold runner systems have three types of channels; Sprues, Runners and Gates. Final step is creating pockets. The concept for creating pockets is that the false body of a standard part is linked to the target body part and is subtracted from the target body.

The overall design processes is from the beginning until a complete drawing of a wax injection mold using the mold base system are completed. The most important part for the study, position of the pattern core and cavity are successfully inserted at the middle that nested between the upper and lower mold plates. Besides, the overall design time is only taking around twenty minutes. The design time can still be reduced by upgrading the performance of the computer. Anyway, the overall design time is shorter when compared to the information from Michael Chan (Director Consultant of a mold maker company -CAD/CAM Service Sdn. Bhd) saying that the normal time to design a complete wax injection mold for simple pattern is around one to two hours. The wax injection mold base system also has prepared an environment to give the user to create and store the different types of wax injection mold that frequently use. This will directly save their time from redrawing all the components of the wax injection mold..

7.0 Conclusions

This project is just a part of countless research that should be done to achieve the aim which is to develop a wax injection moldbase system. In the future research, some improvement and addition could be done for the system. Other types of wax injection moldbase can be added to the system. So, the system will be more useful and fully cover the needs of the mold designer. Besides, the system can benefit further if simulation tools can arrange.

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References

(1) H. Fielder (2003). "*The Effect of Fillers on the Physical Properties of Investment Casting Waxes."* United Kingdom: Dussek Campbell Yates Ltd. Journal.

(2) H. Monks. (2003). *"Flow and Deformation of Casting Waxes in the Solidification Region"* United Kingdom: Remet Corporation. Journal.

(3) Harvey Fielder. (2003). *"The MechanicalProperties of Investment Casting Waxes."* United Kingdom: Remet Corporation. Journal.

(4) W. Bonilla, S. H. Masood and P. Iovenitti. (2001). *"An Investigation of Wax Patterns for Accuracy Improvement in Investment Cast Parts"* Australia: Swinburne University of Technology. Journal.

(5) Jagannath Yammada, Terrence L. Chambers and Suren N. Dwivedi. (2002). *"Intelligent Mold Design Tool for Plastic Injection Molding"* Lafayette: University of Louisiana. Journal.

(6) W.M.Chan, L.Yan, W.Xiang, and B.T. Cheok (2003 *) "A 3D CAD Knowledge Based Assisted Injection Mould Design System"* International Journal of Advanced Manufacturing Technology

(7) Casting development centre (2004). *"The Ten Commandments for Good Casting Design"*, http://www.castingsdev.com

(8) The Institute of Materials, Minerals and Mining (1997). *"Investment Casting – History, Materials And The Future"*, http://www.azom.com/details.asp

(9) John S. Tu et. al. (1995). *"An Integrated Procedure for Modeling Investment Castings"* International Journal of Advanced Manufacturing Technology

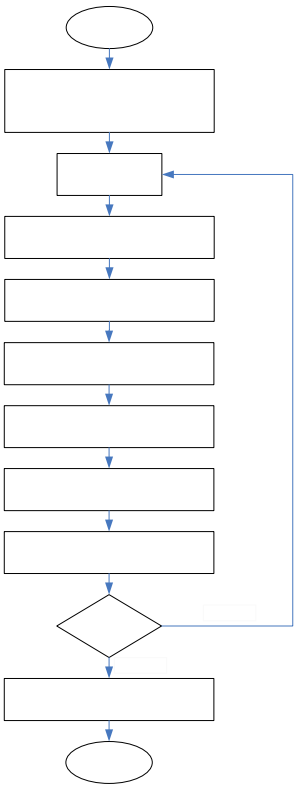


Figure 1: Flow chart of work process

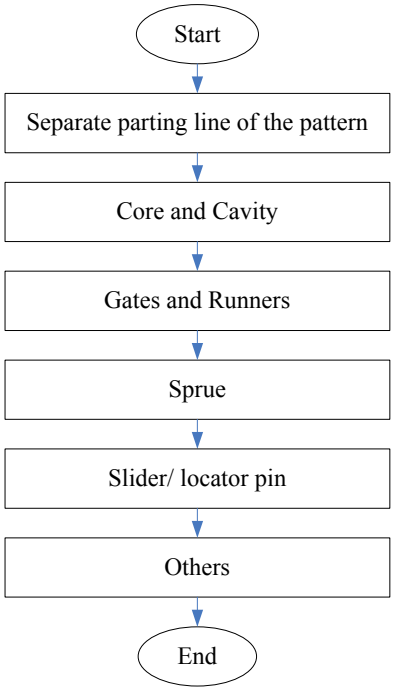


Figure 2 : Flow chart of mold design process

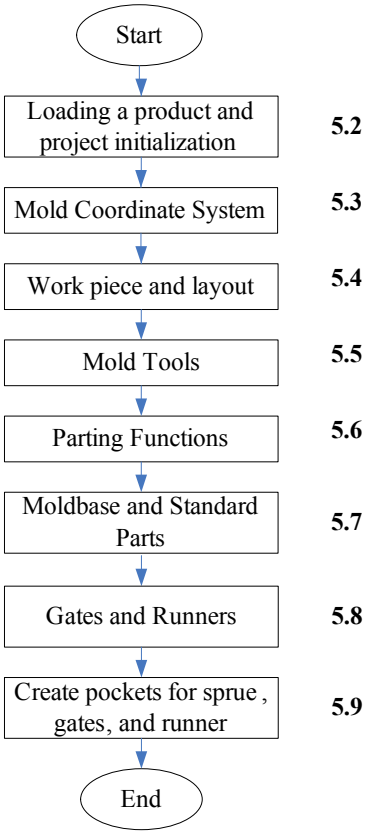
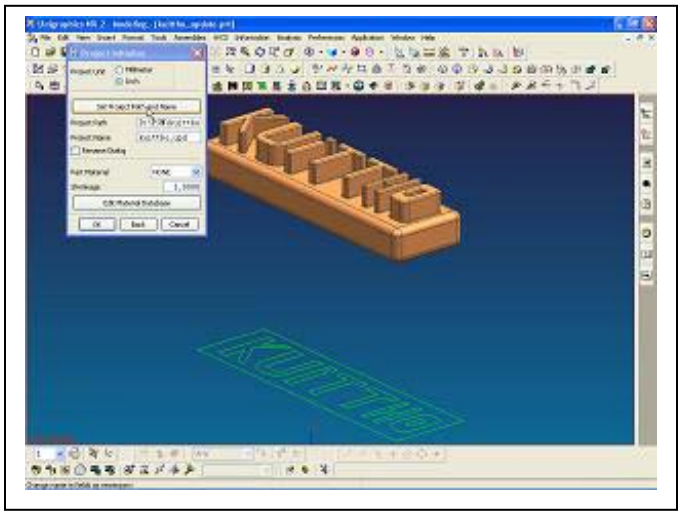
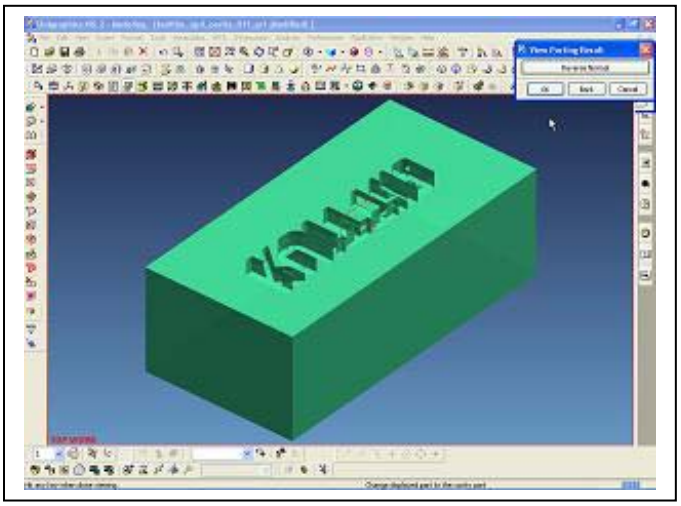


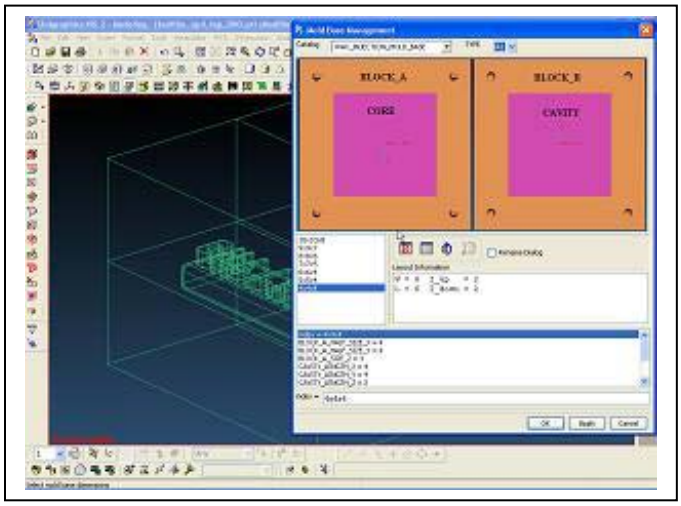
Figure 3 : Flow chart for the implementation of the system



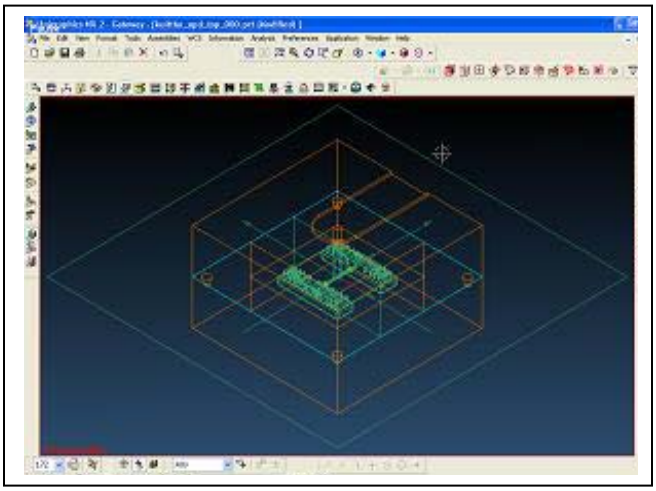
(i) Load product



(ii) Core of the pattern



(iii) Insert mold



(iv) A complete wax injection mold

Figure 4 : Implementation Process Of The System