UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Design and Experimental Study of Keris Mould using DOE

Thesis submitted in accordance with the partial requirement of the
Universiti Teknikal Malaysia Melaka for the
Bachelor of Manufacturing Engineering (Manufacturing Design)

By

Che Ku Norazima Adawiah binti Che Ku Aziz
B050410016

Faculty of Manufacturing Engineering
April 2008

DECLARATION

I hereby, declare this thesis entitle "Design and Experimental Study of Keris Mould using DOE" is the results of my own research except as cited in the reference.

Signature : ……..

Author's Name : CHE KU NORAZIMA ADAWIAH BINTI CHE KU AZIZ

Date : 7 APRIL 2008

UNIVERSITI TEKNIKAL MALAYSIA MELAKA (UTeM)

BORANG PENGESAHAN STATUS TESIS*

JUDUL: DESIGN AND EXPERIMENTAL STUDY OF KERIS MOULD USING DOE

SESI PENGAJIAN: 2007/2008

Saya CHE KU NORAZIMA ADAWIAH BINTI CHE KU AZIZ

mengaku membenarkan tesis (PSM/Sarjana/Doktor Falsafah) ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hak milik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (√)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☑	TIDAK TERHAD	

Disahkan oleh:

(TANDATANGAN PENULIS)

(TANDATANGAN PENYELIA)

Alamat Tetap:
1076, KAMPUNG SEGADING,
GELUGOR KEDAI, 20050 KUALA
TERENGGANU, TERENGGANU

Cop Rasmi:

Tarikh: _____

Tarikh: _____

* Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah dan Sarjana secara penyelidikan, atau disertasi bagi pengajian secara kerja kursus dan penyelidikan, atau Laporan Projek Sarjana Muda (PSM).
** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.

APPROVAL

This thesis submitted to the senate of UTeM and has been accepted as partial fulfillment of the requirement for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design). The members of the supervisory committee are as follow:

……

Main Supervisor

(Official Stamp & Date)

ABSTRACT

The DOE technique is very familiar to an experimental study of any product in manufacturing industry. The most important things of producing the product are by investigating the best solution of the problems occurred and using DOE technique. The problems occurred can be analyzed and an improvement action can be done immediately. There are a lot of advantages of using DOE technique and for example the number of experiments need to be carried out can be define and stated clearly according to the methods that involved in this technique such as Full Factorial, Fractional Factorial, Taguchi Method and etc. Thus, the cost and time can be reduce in product manufacture and also can integrate the product into a high level usage after a few researches had been made. In this project, the scope mostly is to design the experimental study of keris mould using different parameters in the designs made with two different types of level for each parameter. The simulation using MoldflowXpress Analysis software had been done and the result gained then had been analyzed using Minitab software. The result recorded is about injection time of plastic keris mould for each design made. From the analysis process that had been done, the parameter of cold slug seems to be the most effected parameter to the injection time as from the Interaction Plot, only interaction between cold slug and gate recorded for both material used and for Main Effects Plot, the slope of the graph of cold slug is the highest recorded and it means that, the cold slug is the most effected parameter to the responds tested. While for Pareto Chart of the Effects, even though all the parameters do not give any significant effect, the cold slug still is the nearest value to be a significant effect of the injection time.

Keywords: *DOE, Design of Experiment*

ABSTRAK

Teknik *DOE* menajadi satu perkara yang biasa di dalam kajian terhadap sesuatu produk terutamanya di dalam industri pembuatan. Perkara paling utama dalam menghasilkan produk adalah menyiasat langkah terbaik dalam menyelesaikan masalah yang berlaku dan dengan menggunakan teknik ini. Masalah yang dikanalpasti dapat dianalisis dan pembahruan dapat dilakukan dengan kadar segera. Terdapat banyak kelebihan menggunakan teknik *DOE* ini dan sebagai contoh bilangan experimen yang akan dilakukan untuk menentukan langkah terbaik diambil dapat dikenalpasti melaui teknik-teknik yang terdapat dalam DOE ini dan sebagai contohnya ialah *Full Factorial, Fractional Factorial, Taguchi Method* dan sebagainya. Oleh itu, kos dan masa proses pembuatan sesuatu produk dapat dikurangkan. Skop projek ini adalah untuk menghasilkan kajian eksperimetal terhadap beberapa parameter atau faktor yang menyumbang kepada keputusan yang ingin diketahui iaitu *injection time* daripada lukisan yang dihasilkan di mana 4 parameter dipilih dan juga 2 level untuk setiap parameter. Kemudian, simulasi daripada software MoldflowXpress Analysis digunakan untuk mendapatkan keputusan yang kemudiannya akan dianalisis menggunakan software lain iaitu Minitab. Daripada analisis yang dibuat, factor *cold slug* adalah yang memberi kesan paling besar terhadap *injection time* melalui analisis *Interaction Plot (data means), Main Effects Plot* dan *Pareto Chart of the Effects*

Kata kunci: *DOE, Design of Experiment*

DEDICATION

Specially dedicated to; My beloved Father,Che Ku Aziz bin Che Engku Semerang and My Mother, Che Ku Mariah binti Che Ku Chik who are very concern, understanding, patient and supporting. Thanks for everything. To My Brother, All My Friends, I also would like to say thanks. The Work and Success will never be Achieved without All of you.

ACKNOWLEDGEMENTS

In The Name of Allah Almighty And The Most Merciful and Blessings
Be Upon His Messenger Prophet Muhammad S.A.W and His Companions.

Assalamualaikum w.b.t.

I am thankful to Allah the almighty for his divine inspirational guidance, which had helped me in completing this final year project. I would like to convey my sincere thanks to my supervisor, Mr. Zolkarnain bin Marjom for his constructive guidance and patience in fulfilling our aspiration in completing this project. I would like to thanks to technicians involved; Mr. Mr. Nor Fauzi bin Tamin on explaination about Plastic Injection Moulding machine and information regarding to the processes involved in injection moulding. Special thanks to Mr. Ismail bin Jantan, the owner of Azilah Enterprise that kindly lends his books about plastic injection moulding and to Mohammad Idham bin Amzirin for helping me in designing process. Finally, to my family and friends for their support and understanding during the completion this final year project report.

Last but not least, I would like to thank all those who had contributed to my final year project, directly or indirectly.

Wassalam.

Che Ku Norazima Adawiah binti Che Ku Aziz

TABLE OF CONTENTS

3. METHODOLOGY

4. ANALYSIS KERIS MOULD USING DOE TECHNIQUE

5. RESULT INTERPRETING AND DISCUSSION

6. CONCLUSION

LIST OF TABLE

LIST OF FIGURES

LIST OF ABBREVIATION

UTeM	Universiti Teknikal MAlayasia Melaka
RE	Reverse Engineering
CAE	Computer Aided Engineering
PP	Polypropylene
DOE	Design of Experimental
CMM	Coordinate Measuring Machine
CAD	Computer Aided Design
CATIA	Computer Aided Three-dimensional Interactive Application
CAM	Computer Aided Manufacturing
CNC	Computer Numerical Control
SPC	Statistical Process Control

CHAPTER 1
INTRODUCTION

1.1 Background of the Problem

The mould industry becomes very high market in this worldwide. A lot of products had been made using mould engineering concept. The mould and die sector is the leading engineering supporting industry in the country. There are about 350 companies currently employing some 14,000 workers of which 50% are in the skilled and professional categories. The industry trend is expanding where increasing demand for mould making machinery is expected to continue especially with increasing plastics consumption rates in developing countries. The strong export growth observed in recent years is expected to continue as Malaysian companies improve their competitive position by further developing their skilled workforces and investing in leading technologies. (DFAAIT, 2003)

With the capabilities and influences of the mould making technology in this manufacturing industry, there are many studies that had been made to investigate or study about mould design and mould manufacturing process. It is important for a design engineer to know the details about mould design. There are a lot of requirements needed to be fulfilling in order to design and fabricate the mould and various parts of the mould depend on the technique adopted for its manufacturer.

From previous study that has been analyzed, a method of Reverse Engineering is used to produce a keris mould. The study of Reverse Engineering had been applied to the current Dogbone Mould in UTeM's laboratory where the dimensions and several components or part on that mould is measured to get the data

to produce another product with the same requirements in mould making processes. The design and analysis has been done and the most optimized parameters have been identified. Reverse Engineering has been interactively used by several designers to produce or reproduced components or products. From the previous report, Reverse Engineering (RE) had been identified as a process for capturing the geometry of parts/tools, and to generate a conceptual numerical model that could be utilized by computer-aided engineering (CAE) and computer-aided manufacturing (CAM) systems. (Custodio, 2001).

The analysis on injection time of the part design made has been done using the simulation and a process of measuring the product. The results from the analysis then being analyzed and overcome any problem occur. The product injected into the mold in a liquid form need a time for it to fill up the mold require a suitable parameter, such as mold temperature, material temperature and injection location. There are two analyses that used to find a better solution for the injection time of the product by using the variable.

In order to analyze the mold flow of the plastic keris product, there are three (3) parameters that has been considered to be simulated. These parameters are from the analysis in the MoldFlow analysis. The ranges of temperature are also from the same analysis.

i. Melting Temperature (200 ~ 260°C)
ii. Mold Temperature (20 ~ 60°C)
iii. Material : PP (Polypropylene)
    i. PP (Polypropylene) High-flow
    ii. PP (Polypropylene) Low-flow

From the experiments made, the result shows that the results of PP High-flow, it seem that Experiment 7 has the minimum time of injection which is 2.51 sec while for PP Low-flow, also Experiment 7 has the minimum time of injection which is 1.50 sec. The new improved design has been made to the runner of the plastic keris because of the low quality of the product that will be produced and the new design is

analyzes and the result is an acceptable quality for injection location which is suitable for injection moulding.

Unfortunately, it was observed that the design that has been analyzed is lack of details to be produced or fabricate. The results of the mould temperature show that the temperature must be considered in low temperature. (20°C for both high and low flow of PP). It seems like there must be a cooling component need to be put in the design. So, the solution is the water connector must be added to the previous design made. It is important to the designer to verify the previous design is correct and can be proceed to the next process. In this case, the measurement made from previous report need to be verified and ensure that all the requirements for designing the mould is completely considered and included in the design.

Besides the cooling component, the previous design is lack of the specific information and data for producing the keris mould. The most important thing that needs to be considered in order to fabricate the mould is whether the core and cavity of the mould is mating perfectly or not. The combination of hole and shaft must fit when they joined together. Thus, the tolerance must be stated to the hole and shaft in the design made. This requirement will be focused in this study with other additional requirement such as chamfer and so on.

This study also included the approach of design of Experimental (DOE). Further analysis has to be carried out to ensure the validity of the process. Thus new approach of DOE will be used. DOE is a method where the team identifies the parameters that can be controlled and the noise factors it wishes to investigate. The team then designs, conducts, and analyzes experiments to help determine the parameter setpoints to achieve robust performance. (Karl T. Ulrich and Steven D. Eppinger, 2003)

In Japan during the 1950s and 1960s, Dr Genichi Taguchi developed techniques to apply DOE to improve the quality of products and manufacturing process. Beginning with the quality movement of the 1980s, Taguchi's approach to

experimental design started to have an impact on engineering practice in the United States. (Karl T. Ulrich and Steven D. Eppinger, 2003)

DOE is not a substitute for technical knowledge of the system under investigation. In fact, the team should use its understanding of the product and how it operates to choose the right parameters setpoints. Furthermore, the experimental results can be used to build better mathematical models of the product's function. In this way, experimentation complements technical knowledge. (Karl T. Ulrich and Steven D. Eppinger, 2003)

Basic experimental design and analysis for product development can be successfully planned and executed by the development team. However, the field of DOE has many advanced methods to address a number of complicating factors and yield mare useful experimental results. Development teams thus can benefit from consulting with statistician or DOE expert who can assist in designing the experiment and choosing the best analytical approach.

To develop product through DOE, there are seven suggestion processes:

i. Identify control factors, noise factors and performance metrics
ii. Formulate an objective function
iii. Develop the experimental plan
iv. Run the experiment
v. Conduct the analysis
vi. Select and confirm factor setpoints
vii. Reflect and repeat.

(Karl T. Ulrich and Steven D. Eppinger, 2003)

1.2 Problem statement

From the previous research made, the problems of fabricating the mould will occur if the design is not complete and there are lacking identified from the design made. Besides that, the simulation results of mould keris not yet being approved. The mould design is not completed well as there is a few part of keris mould has not been done and analyzed such as water inlet for keris mould. The implementing of water inlet and outlet as a cooling component must be included in the design because the result gained from previous research mentioned that there is an element of decreasing the mould temperature which is about 20°C for both type of materials used in plastic injection moulding (High-flow and Low-flow of PP).The previous design made need to be verified first before the process proceeds with fabricating. In order to fabricate the mould, the detail requirements need to be carried out first. The tolerance of the design made is very important to ensure that the interchangeability between hole and shaft can be achieved and there is no problem occurred during the mating process between core and cavity. This element is not included in the previous study and it is impossible to produce mould without applying the consideration of tolerance in the mould design. The parameters will be selected and simulate using MoldflowXpress software to investigate the optimum parameter of injection moulding using DOE technique.

1.3 Objectives

The objectives of this study are:-

1. To investigate the optimum design parameter using MldflowXpress Analysis using DOE technique in fabricating the keris mould.
2. To identify the mould drawing requirement and design keris mould using standard specification.
3. To interpret the data collected into Minitab software and analysis the significant effect of the design made to the injection time of plastic keris mould.

1.4 Scope of the project

In this project, several tools and equipments will be used in order to fulfill the objectives that have been stated. There are six sequences that must be followed in order to get a systematic and well organized process of this project. The previous design that has been made need to be verified first to ensure that the dimension, shape and the data collected is accurate and able to be used to fabricate the mould. If not, the additional elements must be added to fulfill the standard requirements needed in designing mould and manufacture them later. The process of verify the data is not necessary to use a very accurate equipment such as CMM (Coordinate Measuring Machine) because the previous study has conducted the procedure. For additional element added, the simple tool such as vernier caliper is used to verify the dimension given. After verify, designing process will be carried out and the existing design will be alter to a standard requirement and functional part is included. the design process might be use the approach of CAD (computer Aided Design) software to develop or alteration process a 3-D solid modeling to the core and cavity with additional element for a complete mould design such as water connector, chamfer and a little bit adjustment to the sprue. The software that will be used during this research is Solid Works and the approach of DOE (Design of Experimental) will be carried out to select the proper parameter to get the optimum parameter used in fabricating the keris mould. The design next will be analysis either can be used for further process such as machining. The method that will be used to analyze the design made is MoldflowXpress. After all analysis had been done using the stated technique, the solid modeling data will be transforming into analysis part that will be done using a suitable software to investigate the effect of the design made to the results that had been gained using MoldflowXpress analysis. The software used is Minitab which can be used to analyze the significant effect of the parameters selected to the responds involved (injection time of plastic keris mould).