A STUDY OF A PROBLEMATIC INJECTION PRODUCT, LEADING TO THE RE-DESIGN AND IMPROVEMENT OF THE PRODUCT : STUDY ON RELATIONSHIP MATERIALS, LOCATING GATES AND TYPES OF MOULD BY MOLDFLOW ANALYSIS

T. JUL. 006

MOHD FAIRUZ BIN ALIAS

PROJECT SUPERVISOR : MR. SCOTT KIRBY

GERMAN MALAYSIAN INSTITUTE
PRODUCTION TECHNOLOGY DEPARTMENT

MARCH 2003

PERPUSTAKAAN KUi TTHO
3 0000 00121630 2

VERIFICATION OF PROJECT

I / We* hereby declare that the Report / Thesis has been read and I / We have opinion that the project paper is appropriate in terms of scope coverage and quality for awarding a Bachelor in Production Technology .

Signature : ....

Name of Supervisor : ....S. KIRBY.......

Date : ....21/3/03........

Signature : ....

Name of Supervisor II : ....

Date : ....

Please delete where not applicable.

A STUDY OF A PROBLEMATIC INJECTION PRODUCT, LEADING TO THE RE- DESIGN AND IMPROVEMENT OF THE PRODUCT:
STUDY ON RELATIONSHIP MATERIALS, LOCATING GATES AND TYPES OF MOULD BY MOLDFLOW ANALYSIS

T.JUL.006

MOHD FAIRUZ BIN ALIAS

PROJECT SUPERVISOR
MR. SCOTT KIRBY

GERMAN MALAYSIAN INSTITUTE
PRODUCTION TECHNOLOGY DEPARTMENT

MARCH 2003

OATH

I hereby declare that this project paper is originated from my own idea.

Signature : ....

Name of Student : MOHD FAIRUZ BIN ALIAS

I.C Number : 770409-10-5925

Date : 03/03/03

DEDICATION

I would like to dedicate this report to my beloved family and parents who have the confidence in me to overcome all the obstacle on my journey to success

ACKNOWLEDGEMENT

I wish to express my sincere appreciation to Mr. Scott Kirby the supervisor for this project for the many hours spent discussing, troubleshooting the problem arise and checking the draft of the thesis paper. Your assistance was of prime importance in making the thesis paper complete.

I also greatly appreciate the assistance from all the other during the implementation of this project.

Thank you very much.

ABSTRACT

This thesis paper present about proposed simulation of flow analysis (Moldflow) of plastic part that has produce by injection moulding method. The part, Cable tie selected from we idea to study of relationship material, locating gate and type of mould can be used in this project.

This project intends to review the major problems encountered on the existing product and propose possible solution to make the product more viable and competitive. The investigation scope will also include material selection, as it has been identified as one of major problems uncounted on the existing product. Beside that, in this study a simulation of flow analysis (Moldflow) has been utilised to investigate filling image, temperature reaction, weld lines and air trap phenomena in cooperating the new mould design.

In simulation of flow analysis (Moldflow) we also study on best selected locating gate. From the result we can do analysis and compared with the other results use different locating gate.

TABLE OF CONTENT

List of Tables

List of Symbols and Abbreviations

CAE	Computer Aided Engineering
CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
STL	Stereo lithography
IGES	International geometric exchange standard
MPI	Moldflow Plastic Insight
Deg C	Degree Celsius
Mm	Millimetre
Mpa	Mega Pascal
Cu cm	Cubic centimetre
G	Gram
Min	Minute
J	Joule
Kg	Kilogram
Sec	Second
S	second

List of Appendix

List of Figure

CHAPTER I

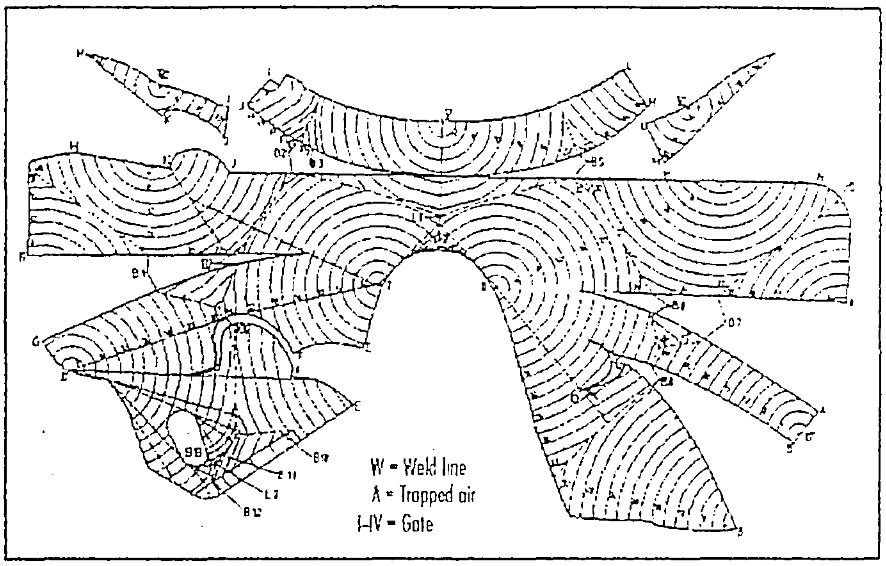
1.0 INTRODUCTION

Development work on the simulation of the injection moulding process started in the mid-1970s when the first simple programs for programmable pocket calculators became available for calculating the pressure loss in specified flow channels. The geometry options then available were cylinders for the gate system and plates and circular segments for the moulded part, depending on whether the melt flowed through a constant or a divergent channel.

1.1 THE FLOW PATTERN METHOD POINTED THE WAY FORWARD

Even 20 years ago, injection moulders and mould builders were already confronted with the same problems as today, namely: where should the gates be located, how many gates should there be, and where can weld lines or even entrapped air occur. At that time, the so-called flow pattern method had been developed by the IKV Plastics Processing Institute of the Technical University of Aachen, which made it possible to simulate cavity filling with a compass and pencil on the basis of a developed view of the moulded part. Once the flow pattern had been compiled, the developed view was cut out and glued to give the 3D moulded part. A new flow pattern had to be compiled for each new gate position and this was naturally very time consuming.

Working on from this, a joint research project was set up with industry under the name CADMOULD with the aim of developing a calculation model for use in the rheological, thermal, and mechanical layout of an injection mould. Those involved in the project were raw materials producers, machine producers, injection moulders and producers of standard mould components. At the same time, MOLDFLOW in Australia also developed a system for theological simulation. These initial programs simply produced tables showing the prevailing pressure losses, viscosities, shear rates and temperatures, by way of a result. This nonetheless marked the start of computer-aided simulation for injection moulding. [9]



Figures 1.0 : Flow pattern method

Simulation of mould filling through a developed view of the moulded part, diagram of wheel lining

Midway through the 1980s, computers were able to calculate flow patterns. Following this, the pace of development of simulation programs increased, and it was soon possible to calculate not only the filling phase, but also the holding pressure phase, as well as the fibber orientation, shrinkage, and warpage.

The product design study shall be strongly focused on the viability, competitiveness and marketability of the product itself. Unlike any other investigations that are involved in survey analysis, this study suggests innovative products that are based mainly on function, features and material to be used.

The product that has been selected is an injection-moulded part. In fact, the task of designing such parts can be extremely difficult due to the complexities of both the part geometry and the moulding process. It is also difficult for experienced designers to work with new plastic material grades that require many processes and perform in a different manner than those materials previously used.

Injection moulding is the most important plastics processing process for engineering & precision parts. The process are considered as a complex process as it involved a lot of variables such as polymer material, complexities of part design, type of the moulds and processing condition set on the machine. Time for tool development and manufacturing are extremely important in this industry. [10]

The development of the tool and the product has to be fast without neglecting their quality. Quality, consistency of the process and cost of the part play a major role in this industry. By adapting what is known as concurrent engineering such as incorporating Plastics CAE / Simulation from the early conceptual design stage it can optimise the result. Computer aided engineering (CAE) is the process of using a computer and appropriate software to assist in the design and engineering of components.

The benefits of using CAE software to design and engineer components include: improved and consistent component quality. Lower costs associated with the need for less prototyping, rework and lower product development cycle time. Improved product design before the commencement of manufacturing lower manufacturing cycle times. [12]

For plastics CAE technology to be widely used in industry, it should provide that it have an acceptable balance of the time, effort, resources used in preparing and running the analysis and most important a reasonably accurate simulation result. Currently, there are two methods used for the plastics CAE or simulation of shell type's plastics structure. This thesis paper attempts to find best material, best locating gate and type of mould can be used in the project. The pre-processing work involved from obtaining the CAD data until completing is also discussed.

CHAPTER II

2.0 LITERATURE REVIEW

We have agreed to divide the tasks according to our discussion. My tasks focus more on Moldflow analysis. The idea is to design and development new product so that the detail design can be thoroughly tested before we prepare to manufacturing. A idea new product calls for a feasibility study, not only about whether or not it is possible to realize a product, but also to identify structural and material problems, liability and safety issues well ahead of time so that all surprises are eliminated. Rather, the identification of problems becomes a part of the product planning.

2.1 CABLE TIES HISTORY

The need to collect, contain and control multiple wires into tightly organized bundles appeared with the invention of the first products that contained electrical wiring systems. Electrical wiring had to be bundled and routed within the equipment to prevent or reduce damage to wiring, isolate wires from moving parts and to provide consistent, organized and efficient wiring layouts to facilitate tracing and servicing of internal wiring systems. [1]

2.2 THE FIRST CABLE TIE

The first device that was used to bundle and route wires effectively were similar in appearance and function to today's standard cable tie. It had a steel pawl or barb inserted at an angle inside its head. Although this design provided fine adjustment and self-locking it required two separate, time consuming manufacturing operations - moulding the tie and insertion of the steel pawl. In addition, there was the possibility that the steel pawl could work loose or break off, with potentially disastrous results if it fell into printed circuits or closely spaced relay contacts. [1]

The next major development was a two-component, self-locking cable tie completely produced from nylon material. Although it was finely adjustable, it still maintained the time-consuming, two-step manufacturing process. Because of its design, this improved cable tie provided better hand-eye coordination and reduced installation time. Over time cable tie design improved steadily and eventually led to the development of a one-piece moulded self-locking nylon cable tie. [1]

2.3 MODERN CABLE TIE

Since the development of the first one-piece, self-locking cable tie its design was steadily refined to improve the effectiveness of the product as a wire bundling device. The basic one-piece, self-locking cable tie now comes in many sizes and styles for a diverse range of applications. It has also been modified into specialty ties with all the qualities of the basic tie, plus added features for different uses. [1]

2.4 CABLE TIE CHARACTERISTICS

A cable tie is a band or length of strap manufactured from a class of polymeric materials known as polyamides (Nylon 6/6). The width, length and head area employ ratcheting mechanisms to bundle and then lock items together. Commercially introduced in 1938, nylon was the first synthetic semi-crystalline polymer whose physical properties compared favourably to some metals. Nylon possesses an outstanding balance of properties, combining strength, moderate stiffness, high service temperature and a high level of toughness. Particularly resistant to repeated impact, nylon has a low coefficient of friction and excellent abrasion resistance. It is resistant to fuels, lubricants, and most chemicals, but is attacked by phenols, strong acids and oxidizing agents. Nylon is inherently susceptible to environmental conditions. However, many cable ties are moisturized to attain optimum performance levels. Nylon products should be stored in a cool, dry area, out of direct sunlight, and sealed in the original packaging material to extend performance levels indefinitely.

2.5 THREE TYPES OF NYLON FOR SPECIFIC APPLICATIONS

2.5.1 General-purpose nylon is suitable for most applications at a continuous temperature up to 150° F. Nylon 6/6, the grade most often used for cable ties, meets UL 94V-2 flammability ratings. Its working temperature range is 40° F. to 185° F.

2.5.2 Heat Stabilized Nylon 6/6 is used for applications with continuous or extended exposure to high temperatures, up to 250° F., and thereby meeting UL standards for electrical applications. HST cable ties contain specially-formulated heat stabilizers to provide additional thermal endurance.

2.5.6 UV Stabilized Nylon 6/6 is used in applications of continuous or extended exposure to outdoor elements. The weather-resistant grade, able to endure additional ultraviolet (UV) light, is produced by incorporating stabilizers in the nylon resin. HST's UV Stabilized Nylon cable ties are available only in black. [6]

2.6 THE NEED FOR PLASTIC FLOW ANALYSIS

The field of flow analysis has gained increasing importance in injection moulding. Flow analysis has provided rational solution to many of the hard-to understand effect that cause problem in the moulding process. These effects have included warping, moulded-in stress, excessive fill pressure, part flashing and other. The interrelationship between part design and moulding process parameters that cause problems of this nature were not well understood in the industry.

Practical experience often was insufficient to identify potential problem and too kneed to have encountered the full range of moulding problem that can be address by techniques such as flow analysis. Hence, much prototyping and mould fine-tuning were necessary before successful moulded product could be achieved.

Computerized flow analysis has emerged as a powerful tool to aid in the implementation of applying injection moulding as the production process of choice to widening spectrum of products. The ability of modem digital computer to perform complex calculation in short periods of time has been the breakthrough that makes flow analysis a tool applicable to increasing number of new parts.

Computer simulation of the injection moulding process is not new. In fact, virtually since the introduction of the computer attempts have been made to develop simulations. However, according to basic flow laws, the flow rate into each section or element must equal the flow rate out each section. This gives a boundary condition Mat allows the flow pattem to be calculated. The divided flow method has proved very successful in practice, enabling a wide range of complex parts to be analysed. The mould is first divided into number of flow paths, then each flow path broken into sections. This modelling has to be done manually, usually by the mould designer. Some skill is required to recognize the various flow paths and to be able to align the section in the direction of flow. [12]

2.7 ADVANTAGES OF FLOW ANALYSIS

There are multitudes of factor that must be considered when creating a plastics part or mould design. Key influence such as component geometry, wall thickness, the number and position of the gates, material choice, shrinkage allowances and mould design are all interrelated. Part and mould design cannot be based purely on form and function but must also consider the effect of manufacturing. [2]

The CAE simulation provides engineers, designers, moulders with a visual and numerical feedback about what actually happens inside the mould cavity during the injection moulding process.

2.7.1 ADVANTAGES TO PRODUCT DESIGNER

Product designer will always be concerned if the part that he produced can be injected or will the part fill at all especially with the larger injection moulded component. The relationships among material structural properties, cosmetic properties and processing properties are generally hazy in the designer mind, and flow analysis provides a way to evaluate different materials in the design stage and the processing related characteristic in a scientific manner.

What will be the part wall thickness was another primary consideration for the cost of the moulded product. The ability to thin wall on the product result in obvious saving in material (comprises 40% of finish product cost). By assigning thin wall thickness indirectly it will reduce the cycle time of the moulded part. This will increase productivity of the moulded plant and it will reflect the cost of the product. [3]

The ability of plastic materials to be form into attractive styled has long been recognized. This has led to an increasing use of plastic materials for application requiring high degree of aesthetical appeal. Proper use of flow analysis tool can help assure product designer that sufficient latitude exists in the design to allow gates to be position to protect the aesthetic properties of the design, while at the same time allowing production of the item at reasonable cost.

2.7.2 ADVANTAGES TO MOULD DESIGNER/MOULDMAKERS

Good fill pattern is very important in any injection moulded component. A good fill pattern for a moulding is one that is unidirectional and consistent molecular orientation in the moulded product. Flow analysis helps to avoid warpage problem caused by differential orientation, an effect that is the best demonstrated by warpage that occurs in thin centre gated disks. [3]

In order to achieve a controlled fill pattern, the mould designer must select the number and location of gates that will result in the desire pattern. Flow analysis can help by allowing the designer to try multiple of gate location and evaluate the impact on the moulding process.

Normally the balance runner systems are certainly desirable but it may lead to problem in mould cooling or increase the cost due to excessive runner-to-part weight. By using flow analysis it allow the best designs of runner to balance for pressure, temperature, or combination of both. They also allow an evaluation of the shear rate and degree of frictional heating that will be produced in the runner system, which can avoid the problem of material degradation or excessive melt temperature variation delivered to the mould cavity. [3]

One of the major benefits of the flow analysis is the increased probability that the mould run successfully the first time in the trial. This will save lot of time and money.

2.7.3 ADVANTAGES TO INJECTION MOULDER

Flow analysis can provided an objective view of the impact of changes of primary injection moulding process parameter such as melt temperature, mould temperature, injection speed and injection pressure.

Optimisations of the process parameter allows the moulder to produce parts with minimal levels of residual stress, which can result in post moulding warpage or even mechanical failure of the product. [3]