# INTEGRASI REKABENTUK UNTUK PEMASANGAN (DFA) DAN REKABENTUK UNTUK PEMODULARAN (DFMo) UNTUK MENINGKATKAN PRESTASI PRODUK – ANALISIS ALIRAN ACUAN

*(INTEGRATION OF DESIGN FOR ASSEMBLY (DFA) AND DESIGN FOR MODULARITY (DFMo) TO ENHANCE PRODUCT PERFORMANCE - MOLDFLOW ANALYSIS)*

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# ABSTRAK

Rekabentuk untuk Pemasangan (DFA) dan Rekabentuk untuk Pemodularan (DFMo) adalah salah satu kaedah yang lazimnya digunakan bagi meningkatkan prestasi sesuatu produk itu. Secara umumnya, konsep Rekabentuk untuk Pemasangan (DFA) adalah mengurangkan jumlah komponen - komponen kecil dengan cara menggabungkan komponen - komponen kecil itu menjadi satu komponen besar bagi memudahkan pemasangan produk itu. Manakala Rekabentuk untuk Pemodularan (DFMo) pula, berkonsepkan memecahkan sesuatu komponen yang besar itu menjadi beberapa komponen - komponen yang kecil bagi mengurangkan kerumitan pemasangan komponen – komponen itu. Projek ini bertujuan untuk mengkaji konsep – konsep asas yang terdapat pada Rekabentuk untuk Pemasangan (DFA) dan Rekabentuk untuk Pemodularan (DFMo) dan menggabungkan kedua – dua konsep ini bagi meningkatkan prestasi sesuatu produk itu dengan cara mengurangkan kerumitan pemasangan komponen itu dan dalam masa yang sama mengurangkan jumlah komponen – komponen bahagian yang terlibat. Bagi kajian kes, dua jenis soket yang berlainan; soket biasa dan juga modular soket yang di bangunkan pada projek yang lepas digunakan. Analisis dijalankan dengan menggunakan perisian Analisis Aliran Acuan dimana kedua – dua soket itu akan dianalisis dan keputusan analisis itu akan dibandingkan dari segi parameter – parameter tertentu seperti masa aliran, tekanan, suhu, penentuan lokasi dan jumlah laluan masukan yang sesuai, kualiti dan sebagainya. Hasil daripada analisis yang dijalankan ini, keputusan menunjukkan modular soket adalah lebih baik daripada soket biasa dari segi masa aliran masukan dan lain – lain parameter.

# ABSTRACT

Design for Assembly (DFA) and Design for Modularity (DFMo) two of the methods used in manufacturing industry to enhance performance of product. Generally, the concepts of Design for Assembly (DFA) is to reduce number of parts in order to reduce product complexity, while Design for Modularity (DFMo) is try to reduce parts complexity by increasing number of parts. This project is required to study the basic concept for Design for Assembly (DFA) and Design for Modularity (DFMo) and combine these two approaches to enhance product performance by reducing parts complexity and at the same time reducing number of parts. For case study, two different types of sockets that used; existing socket and modular socket from the previous project. Using Moldflow analysis software, these sockets were analyzed and the result will compare for certain parameter such as filling time, pressure distribution, suitable location for injection gate, quality prediction and so on. From this analysis, show that the modular socket is better than existing socket in filling time and other parameter.

# CHAPTER 1

# INTRODUCTION

## 1.1 INTRODUCTION

In the past, products have been designed that could not be produced. Products have been released for production that could only be made to work in the model when prototypes were built and modified by highly skilled technicians. Effective product development must go beyond the traditional steps of acquiring and implementing product and process design technology as the solution. Products are initially conceptualized to provide a particular capability and meet identified performance objectives and specifications. Given these specifications, a product can be designed in many different ways. The designer's objective is to optimize the product design with the production system.

Generally, the designer works within the context of an existing production system that can only be minimally modified. However in some cases, the production system will be designed or redesigned in conjunction with the design of the product. When design engineers and manufacturing engineers work together to design and rationalize both the product and production and support processes, it is known as integrated product and process design. The designer's consideration of design for manufacturability, cost, reliability and maintainability is the starting point for integrated product development

Product design is the critical first step in the manufacturing process. This first step decides the method of assembly, component tolerances, number of adjustments and type of fabrication tooling. Together, these decisions determine a great part of the manufacturing cost and total product cost. One way to ensure that your new product has been designed for economical production is to use the design for assembly (DFA) approach.

Design for assembly (DFA) is a technique for reducing the cost of a product through simplification of its design [1]. This cost reduction occurs by reducing the number of individual parts in the assembly and then ensuring that the remaining parts are easy to handle and assemble. National Cash Register Co. estimates a savings of $12,000, over the life of a new product, for each screw the designers eliminate. By applying the DFA process, many leading companies such as Brown & Sharpe, Black & Decker, Carrier, DEC, Ford, Kodak, GM, IBM, NCR, Xerox and more have saved millions. Cost reductions of 20 percent to 35 percent are commonly achieved through the use of the DFA methodology [2].

Modular design is the popular topic in industry today, though there is no systematic method in place that guarantees a modular design. The use of an appropriate form of modular structuring makes it possible for a given problem to be considered in terms of a set of smaller components. This principle has long been established in engineering and is generally only possible where a well-defined set of interface standards exist. To make good use of a modular structure, defining interfaces is not enough; the design process needs to be based on a separation of concerns, by grouping functions within modules in such a way that their interdependence is minimized [3].

The successful use of modularity should be reflected in quality characteristics, including: maintainability, testability, usability, and reliability. Two quality measures used since the 1970's for assessing the extent of modular structuring in applications software are: 'coupling' and 'cohesion'. They are useful from a management perspective also, in that they can be used to identify the complexity of a system in terms of the form and interdependence of the component modules, and such evidence can inform risk management activities.

Over the past few years, the use of flow simulation software to ensure design for manufacturability has increased tremendously. Designer successfully used these software packages observe filling patterns, optimize gate locations; determine cooling line location, and estimate shrinkage and warpage. This has lead to reduction in product development time and fewer mold corrections. As the usage of the software increased, however, some concerns were raised regarding the validity of results of flow simulation. While the models and assumptions employed for the software calculation are evolving, they still present problems in predicting the filling, cooling, shrinkage and warpage of injection mold part. For this study, fill time and fill pressures are two parameters taken into consideration. For this work, a case study of existing and modular socket from previous project will be used to clarify the methodology.

**Previous project overview**

Nowadays, there are many types of series socket in market but the problem is the socket mold and customers needed. For the socket mold, the company needs to produce many molds for the socket; one connection, two connections and so on to satisfy customer need. Modular socket is designed to solve the problem from existing socket and it also upgrade by adding inlet and outlet connector. The inlet connector is used to connect the modular socket to the customer's needed and the outlet connector is used to connect the socket to the power supply using a cable. Besides that, the modular socket needed more inspection in moldability to improve the socket's performance for day to days. Because of that, mold filling analysis is used to make some inspection and improve the product performance.

## 1.2 OBJECTIVES

The objectives of project are listed as below:

i. To study the concepts and similarity of Design for Assembly (DFA) and Design for Modularity (DFMo).
ii. To understand the previous project – modular socket.
iii. To compare existing and modular design based on mold flow analysis.
iv. To suggest design improvement based on Design for Assembly (DFA) and Design for Modularity (DFMo) guideline.

## 1.3 SCOPE OF PROJECT

The scope of this project is to study the concept of Design for Assembly (DFA), Design for Modularity (DFMo) and compare them based on moldflow analysis. In this study, the effects of increasing gate number in fill time, pressure distribution, weld line and temperature will be investigate. It also provides an insight to unforeseen problems commonly related to injection molding process such as weld line and warpage and some improvement will be suggested. As case study, two product to represent existing design and modular design of socket will used.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 DESIGN FOR ASSEMBLY (DFA)

Design for Assembly (DFA) is the key elements of Concurrent Engineering. DFA is a simple, structured analysis technique which gives design teams the information they need to reduce product costs by simplifying product structure and optiming manufacturing processes. The aim of design for assembly (DFA) is to simplify the product so that the cost of assembly is reduced. However, consequences of applying DFA usually include improved quality and reliability and a reduction in production equipment and part inventory. These secondary benefits often outweigh the cost reductions in assembly [3]. DFA recognizes the need to analyze both the part design and the whole product for any assembly problems early in the design process. DFA can be defined as "a process for improving product design for easy and low-cost assembly, focusing on functionality and on assemblability concurrently" [4].

The practice of DFA as a distinct feature of designing is a relatively recent development, but many companies have been essentially doing DFA for a long time. For example, General Electric published an internal manufacturing productivity handbook in the 1960's as a set of guidelines and manufacturing data for designers to follow [4]. These guidelines embedded many of the principles of DFA without ever actually calling it that or distinguishing it from the rest of the product development process.

### 2.1.1 General Description

Generally, the designer is guided through the analyses, which are presented in a series of assessment charts. The charts are based on empirical data gathered by knowledge engineering exercises with industrial experts and organised in an easy-to-use worksheet format. During the evaluation, the designer is required to assess component functionality, form, manufacturing processes and assembly characteristics using values extracted from the charts according to component properties. In this way, the designer is able to quantify the suitability of the design. There are four distinct stages to the evaluation as shown in Figure 2.1 [5].

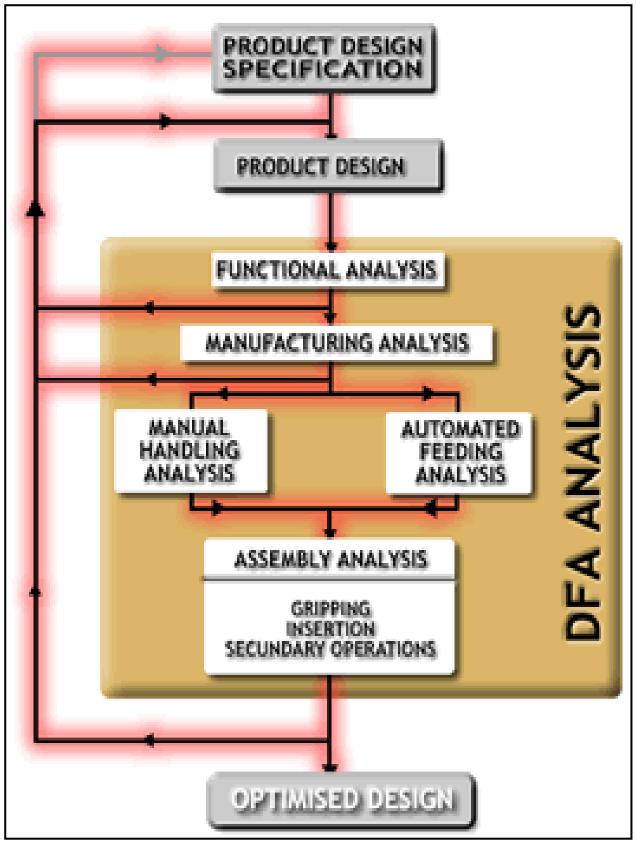



Figure 2.1 DFA analysis flow chart [Brown, Swith, 1999]

### 2.1.2 Typical DFA analysis

#### (a) Functional analysis

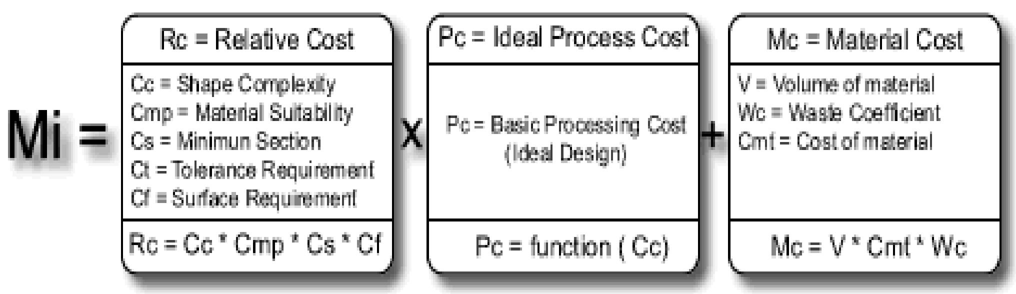
The Functional Analysis facilitates part count reduction by evaluation of each component in order to determine whether it is essential for the performance of the product. Individual components are assessed in terms of their relative motion, material type and the need for removal for replacement or repair, according to nine questions presented on the evaluation sheet. Thus, the designer is able to identify parts that may be eliminated, component clusters that may be replaced by single integrated pieces and opportunities for subassembly partitioning. The evaluation classifies parts as functional (A) or non-functional (B) components. The Design Efficiency (E) is calculated as the ratio of functional to non-functional parts as shown below [5]:

$$E = \left[ \frac{A}{A+B} \right] * 100 \qquad \textbf{(1)}$$

When developing a new product, a design efficiency as high as possible should be achieved with 60%-70% as a recommended threshold based on a study of 'good' designs.

### (b) Manufacturability Analysis

The Manufacturability Analysis determines the relative cost of producing each component based on the manufacturing processes used. This processing cost is determined using a basic Processing Cost per annum (Pc) for an ideal design (independent of design features), a design-dependent Relative Cost (Rc) and Material Cost (Mc). This requires the engineer to consider component properties such as shape complexity, tolerances and surface finish and the material suitability and usage, for the particular manufacturing processes chosen.




**(2)**

### (c) Handling Analysis

The Handling Analysis evaluates the suitability of a component for manual handling and automated feeding to the point of assembly. The evaluation considers component shape characteristics, size, weight, orientation and mechanical properties. Careful selection of manual handling operations and feeding technology leads to improvements in safety and reduces the likelihood of component damage or incorrect insertions. The main benefits include reduced capital spend on equipment and improved assembly times.

### (d) Assembly Analysis

The Assembly Analysis is used to highlight problems and inefficient operations associated with the build sequence and component interfaces, and to identify the tooling requirements of the design. The assembly analysis scores the difficulty associated with gripping each component and inserting it into the assembly for both manual and automated operations. Ease of insertion is dependent upon the position of components in the assembly sequence and hence DFA encourages the engineer to consider design from an assembly point of view. As a consequence of this, the success of any DFA evaluation is dependent upon the assembly sequence used as the basis for the analysis. The designer is required by the methodology to construct an assembly sequence and the graphical notation.

### 2.1.3 Basic DFA Guidelines

Here are some basic guidelines for DFA. Generally, when start with a concept design and then go through each of these guidelines, decide whether or not it is applicable, and the modify the concept to satisfy the guideline.

1) Minimise part count by incorporating multiple functions into single parts
2) Modularise multiple parts into single subassemblies
3) Assemble in open space, not in confined spaces; never bury important components
4) Prefer self-locating parts

5) Standardise to reduce part variety
6) Maximise part symmetry
7) Eliminate tangly parts
8) Provide orienting features on nonsymmetries
9) Design the mating features for easy insertion
10) Provide alignment features
11) Insert new parts into an assembly from above
12) Eliminate re-orientation of both parts and assemblies
13) Eliminate fasteners
14) Deep channels should be sufficiently wide to provide access to fastening tools; eliminate channels if possible
15) Prefer easily handled parts

### 2.1.4 Benefit of Design For Assembly (DFA)

In general, the benefit can be identified using the DFA process methodology are:

- Understanding the impact of the design on the manufacturing
- Promotes the concept of "right-first-time"
- Structured methodology for product assessment and development.
- Promotes creativity and innovation.
- Encourage teamwork.

It will also improve the product quality through part-count reduction. Part count reduction will promote:

- Fewer opportunities for misalignment.
- Fewer tolerance stack-up problems.
- Fewer adjustments.
- Fewer mating points.

Cost is greatly improved due to:

- Less material to inventory.
- Fewer assembly stations.
- Less automatic assembly equipment.
- Less dedicated fabrication tooling.
- Less paperwork and fewer drawings.

## 2.2 DESIGN FOR MODULARITY (DFMo)

Modular design is a design technique that can be used to develop complex products using similar components. Components used in a modular product must have features that enable them to be coupled together to form a complex product. Modular design can be viewed as the process of producing units that perform discrete functions, then connecting the units together to provide a variety of functions. Modular design emphasizes the minimization of interactions between components, which will enable components to be designed and produced independently. Each component designed for modularity is supposed to support one or more functions. When components are structured together to form a product, they will support a larger or general function. This shows the importance of analyzing the product function and decomposing it into sub-functions that can be satisfied by different functional modules.

### (a) Module

A module is a bounded contiguous group of statements having a single name and that can be treated as a unit. In other words, a single block in a pile of blocks. Optimizin*g* is the process of seeking the perfect solution. Satisficing is the process of seeking a better, but not necessarily perfect, solution. There are no perfect systems and there are always constraints. So, satisficing, not optimizing, is the goal of system design.

Separate modules should be relatively independent (loosely coupled). This facilitates development, maintenance by teams; reduces chance of unintended ripple effects on other modules when changes made to a module. Any system always represents some kind of tradeoff between functionality (meeting the business needs) and the resources available (constraints). The goal of design is an improved system, one that better meets the needs of the organization. Modularity is important because:

- it allows assignment of different programmers and analysts to separate tasks
- small sections can be developed independently
- maintenance causes minimal disruption.

### 2.2.1 Modularity in application

Modularity can be applied in the areas of product design, design problems, production systems, or all three. It is preferable to use modular design in all three types at the same time; this can be done by using a modular design process to design modular products and to produce them using a modular production system or modular manufacturing processes.

#### (a) Modularity in products

Modular products are products that fulfill various overall functions through the combination of distinct building blocks or modules, in the sense that the overall function performed by the product can be divided into sub-functions that can be implemented by different modules or components. An important aspect of modular products is the creation of basic core unit to which different elements (modules) can be fitted, thus enabling a variety of versions of the same module to be produced. The core should have sufficient capacity to cope with all expected variations in performance and usage [6].

A good example of modular products is the personal computer (PC). Any PC consists of several components or building blocks such as hard drive, RAM, CPU, CD-ROM, video card, and many other modules. Many modules can be modified or changed with little or no modification to the other modules. For example, a CPU can be sold with different combinations of hard drives, RAM, and other options. Through the use of such modular components, a company can choose from a variety of major components and form a product that can meet the customers' needs.

### (b) Modularity in Design Problems

Most of the design problems can be broken down into a set of easy-to-manage simpler sub-problems. Sometimes complex problems are reduced into easier sub-problem, where a small change in the solution of one sub-problem can lead to a change in other sub-problems' solutions. This means that the decomposition has resulted in functionally dependent sub-problems. Modularity focuses on decomposing the overall problem into functionally independent sub-problems, in which interaction or independence between sub-problems is minimized. Thus, a change in other problem or it may have no effect on other sub-problems [6].

### (c) Modularity in Production Systems

Modularity in production systems aims at building production systems from standardized modular machines. The fact that a wide diversity of production requirements exist has led to the introduction of a variety of the production machinery and a lack of agreement on what the building blocks should be. This means that there are no standards for modular machinery must be classified into functional groups from which a selection of modular production system can be made to respond to different production requirements [6].

## 2.2.2 Type of Modularity

### (a) Component-Swapping Modularity

Different product variants belonging to the same product family are created by combining two or more alternative types of components with the same basic component or product. Figure 2.2 illustrates the swapping modularity in which two alternative component (the small rectangular block and the triangular) are combined with the same basic component (the big block), forming product variants belonging to the same product family. An example in the computer industry is illustrated by matching different types of CD-ROMs, monitors, and keyboards with the same motherboard.

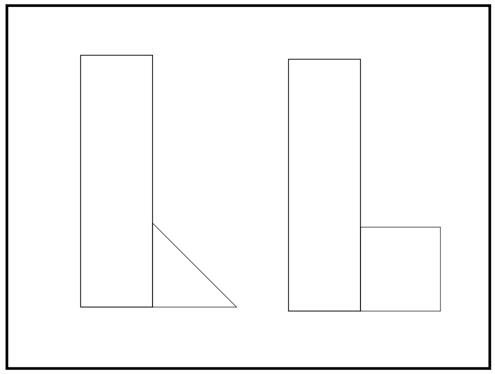


Figure 2.2 Component-Swapping Modularity

**(b) Components-Sharing Modularity**

Different product variants belonging to different product families are created by combining different modules sharing the same basic component. Component-sharing and components-swapping modularity are identical except that swapping involves the same basic product using different components and sharing involves different basic products using the same component. Figure 2.3 shows two different basic components (block and triangular) sharing the same component (the circle). Component-sharing modularity in the computer industry is represented by the use of the same power cord, monitor, or microprocessor in different product (computer) families.

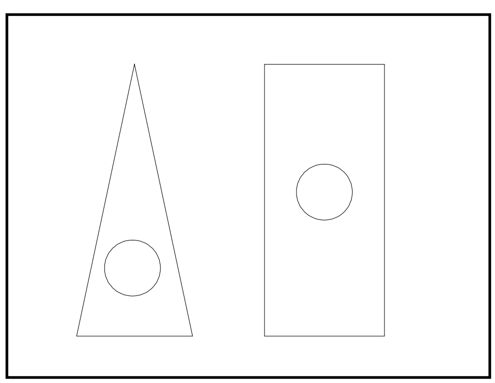


Figure 2.3 Component-Sharing Modularity

**(c) Fabricate-to-Fit Modularity**

One or more standard components are used with one or more infinitely variable additional components. Variation is usually associated with physical dimensions that can be modified. Figure 2.4 illustrates a component with variable length (the block) that can be combined with two standard components (the triangular) forming product variants. A common example of this kind of modularity is cable assemblies in which two standard connectors can be used with arbitrary length of cable.

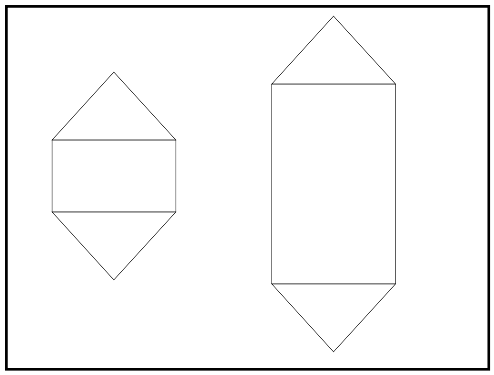


Figure 2.4 Fabricate-to-Fit Modularity

**(d) Bus Modularity**

This type of modularity occurs when a module can be matched with any number of basic components. Bus modularity allows the number and location of basic components in a product to vary. Bus modularity is illustrated in figure 2.5. An example of bus modularity is a computer where different input and output units, in addition to different types of mice, RAMs, and hard drives, can exist and vary in both their location and number.

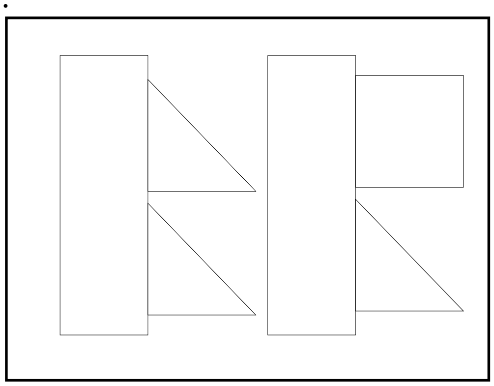


Figure 2.5 Bus Modularity

### 2.2.3 Guideline of Design for Modularity

1 - Simplify the design and reduce the number of parts.

2 - Standardize and use common parts and materials.

3 - Design for ease of fabrication.

4 - Design within process capabilities and avoid unneeded surface finish requirements.

5 - Mistake-proof product design and assembly (poka – yoke).

6 - Design for parts orientation and handling.

7 - Minimize flexible parts and interconnections.

8 - Ease of assembly and efficient to joining and fastening.

## 2.3 COMPARISON AND SIMILARITY

### 2.3.1 Similarity

Table 2.1 The similarity of Design For Assembly (DFA) and Design For Modularity (DFMo)

| CHARACTERISTIC | DESIGN FOR ASSEMBLY (DFA) | DESIGN FOR MODULARITY (DFMo) |
|---|---|---|
| 1 - Reduce Part | Modularise multiple parts into single subassemblies | Simplify the design and reduce the number of parts |
| 2 - Standardize | Standardize to reduce part variety | Standardize and use common parts and materials |
| 3 - Insertion Part | Insert new part into an assembly from above | Design for ease of assembly |
| 4 - Orientation | Analyze each part for ease of handling | Design for parts orientation and handling |
| 5 - Assembly | Provide alignment features | Building in self-fastening features |

### 2.3.2 Comparison

Table 2.2 The comparison of Design For Assembly (DFA) and Design For Modularity (DFMo)

| CHARACTERISTIC | DESIGN FOR ASSEMBLY (DFA) | DESIGN FOR MODULARITY (DFMo) |
|---|---|---|
| 1 - Assembly time | Reduce assembly time and saving in material costs | Faster |
| 2 - Connection | Maximize flexible parts | Minimize flexible parts and interconnections |
| 3 - Joining | Provide orienting features on nonsymmetries | Maximize part symmetry but design for efficient joining and fastening |
| 4 - Finishing | Surface finish requirement | Design within process capabilities and avoid unneeded surface finish requirements |
| 5 - Design | Design for ease fabrication | Design foe ease of assembly |
| 6 - Replacement part | Difficult to replace | Modules are easy to replace |

## 2.4 MOLD FILLING ANALYSIS

Conventional approach in mold design for injection molding is based on allowances for post mold shrinkage of the part. Experienced designers account for possible warping by allowing for “windage” in tool design. Conventional practice also involves an iteration of modification on the existing mold until the molded part is within specification as shown in Figure 2.6 such procedure results in long and expensive product development time.

In order to cut product development, time and cost, mold flow simulation software like Moldflow’s Part Advisor (MPA) is used to predict the interaction between product design and mold (Figure 2.7) [7]. The need for such analysis becomes more critical since the material used involves fiber reinforcement. During injection molding, fiber orientation occur inevitably causing anisotropy that effects the final parts properties and characteristics. However, by predicting beforehand, the anisotropy can be utilized to make the composite part lighter, stiffer, stronger and more reliable than the uncontrolled composites [7].

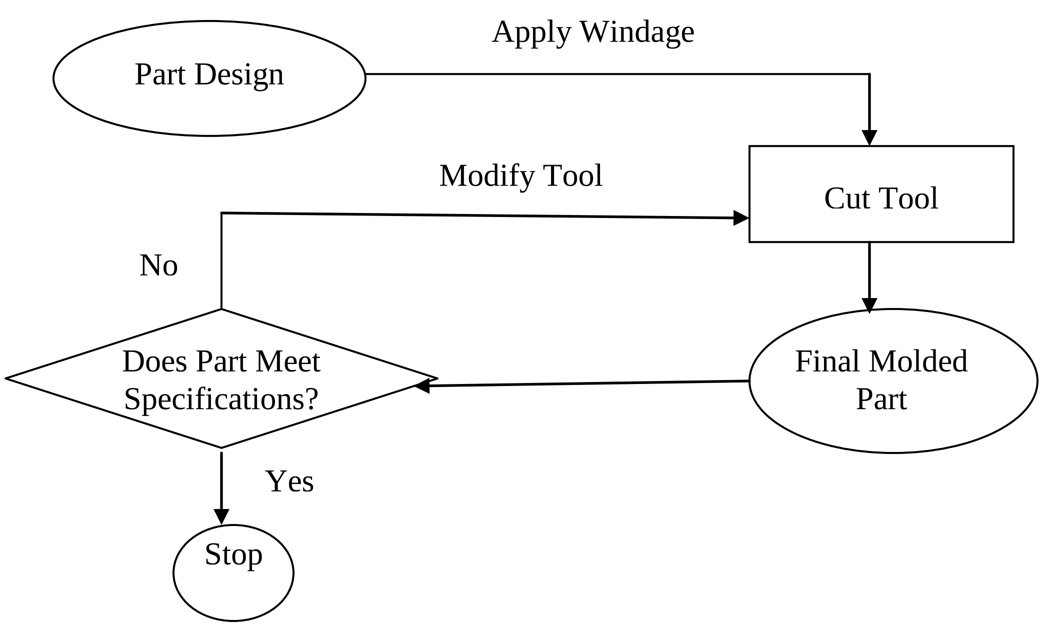



Figure 2.6 conventional approaches to injection molding

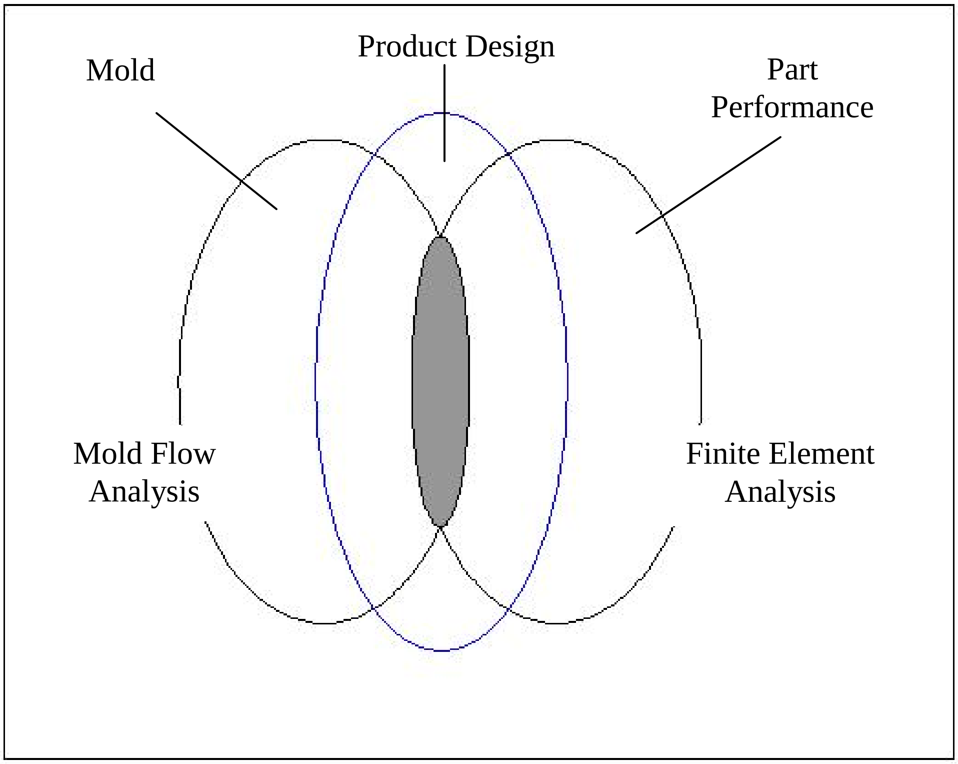



Figure 2.7 Interaction of mold design, product design and part performance

Moldflow Part Advisor (MPA) software was developed by Moldflow Corporation to aid designer in plastic industries for several objectives:

i. reduce product development time and rework, hence decreasing overall costs;
ii. reduce manufacturing cycle time;
iii. improve product design and foresee any problems related to product manufacturability;
iv. provide options for various processing parameters and materials for both plastic and composite product.

# CHAPTER 3

## METHODOLOGY

In order to complete and make this project successful, the methodology is used as shown in Figure 3.1:

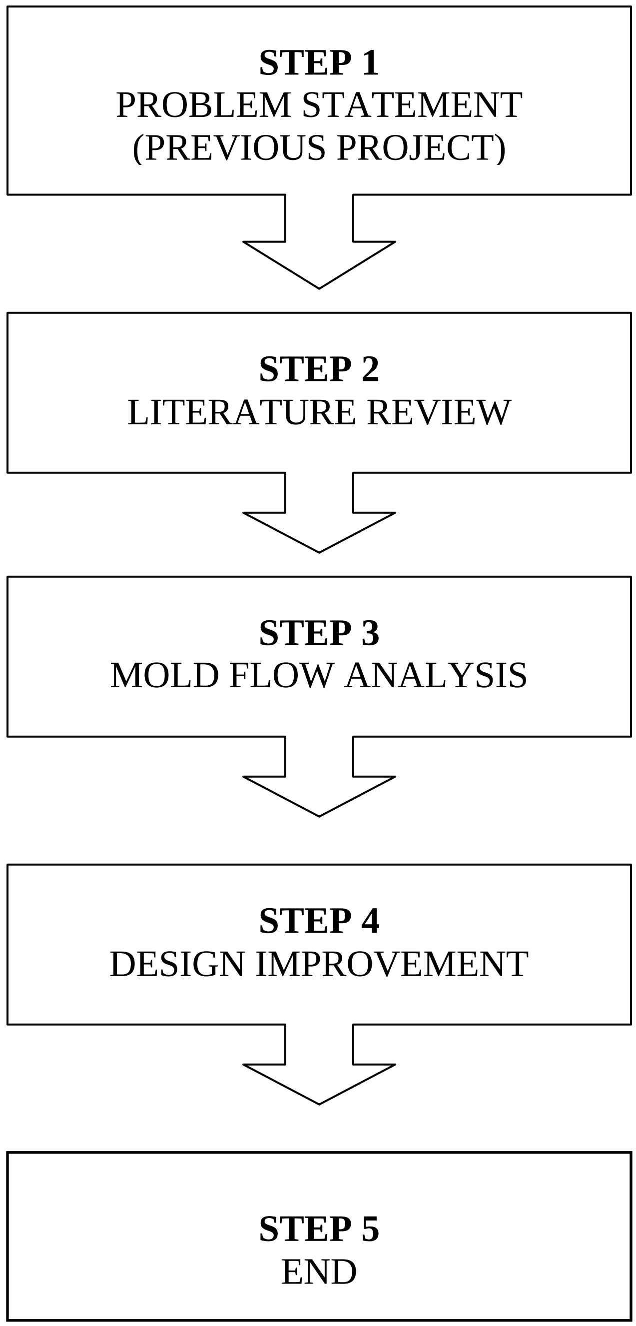



Figure 3.1 Steps for the design process

## 3.1 PROBLEM STATEMENT

This step includes the understanding the design problem and conceptual design. Nowadays socket that made by injection molding will cause some problem in certain aspect. By using the Mold flow's Part Advisor (MPA) in IDEAS, we can identify the suitable material, how much injections and the suitable melt temperature. By applying all information in injection molding, the performance and quality of the socket can be improved.

Other than that, it also has to applying the concept of Design For Assembly (DFA) and Design For Modularity (DFMo) for this socket. This concepts have their own characteristics; Design For Assembly (DFA) approach is try to reduce number of parts in order to reduce product complexity, while design for modularity (DFMo) is try to reduce parts complexity by increasing number of parts. By combining both approaches, the complexity of socket can be reduced and at the same time reducing number of parts. . Reducing parts complexity may simplify manufacturing, assembly and disassembly process and maintenance tasks.

## 3.2 LITERATURE REVIEW

DFA is a simple, structured analysis technique which gives design teams the information they need to reduce product costs by simplifying product structure and optiming manufacturing processes. The aim of design for assembly (DFA) is to simplify the product so that the cost of assembly is reduced. However, consequences of applying DFA usually include improved quality and reliability and a reduction in production equipment and part inventory. These secondary benefits often outweigh the cost reductions in assembly.

In order to cut product development, cycle time and cost, mold flow simulation software like Moldflow's Part Advisor (MPA) is used to predict the interaction between product design and mold. The need for such analysis becomes more critical since the material used involves fiber reinforcement. During injection molding, fiber orientation occur inevitably causing anisotropy that effects the final parts properties and characteristics. However, by predicting beforehand, the anisotropy can be utilized to make the composite part lighter, stiffer, stronger and more reliable than the uncontrolled composites.

## 3.3 MOLD FLOW ANALYSIS

In this step, the suitable material that will be injected in injection molding is selected. This selection will consider many aspects. Not so light, not so heavy and easy to fill all molded. The selection of the material is important in order to make the process or activities completed without any problem. Basically, these selections also incriminate cost by doing this product. The material had been selected is poly (Acrylonitrile Butadiene Styrene-ABS) (Polylac 717-C, Chi-mei Corp.) with melt temperature 200°C, 220°C, 240°C and mold temperature was maintained at 45°C.

After that, the next activity is made a specific drawing for all two type of socket used IDEAS software. The drawing completed with all dimension based on the original socket. In this step, error will exists like the dimension of the components is not exactly perfect but the important thing is the drawing must be solid. This step may take a few times for completing the drawing.

## 3.4 DESIGN IMPROVEMENT

In this step, after the drawing of the socket has done, the next step is mold flow analysis using Mold flow's Part Advisor (MPA) in IDEAS. The use of MPA analysis is to ensure design for manufacturability has increased tremendously. Designers have successfully used these MPA analysis to observe filling patterns, optimize gate locations; determine cooling line locations and estimate shrinkage and warpage. This has lead to reduction in product development time and fewer mold corrections. As the usage of the software increased, however, some concerns were raised regarding the validity of results of flow simulation. While the models and assumptions employed for the software calculations are evolving, the still present problem in predicting the filling, cooling, shrinkage and warpage of injection mold part.

In MPA analysis, the main interest is to see the effect of increasing gate number of fill time, pressure distribution, weld line and temperature. The result from this analysis can be generated after the analysis has done. From that result, the possible problem can be identifying such as suitable gate, suitable material and so on. Based on the advisor, the socket can be improved and the analysis is made for many times to get accurate result.

# CHAPTER 4

## PART MODELING

### 4.1 MOLDFLOW SIMULATION PROCESS

In order to make the analysis using Moldflow Part Advisor (MPA), the following step as shown in Figure 4.1 has followed:

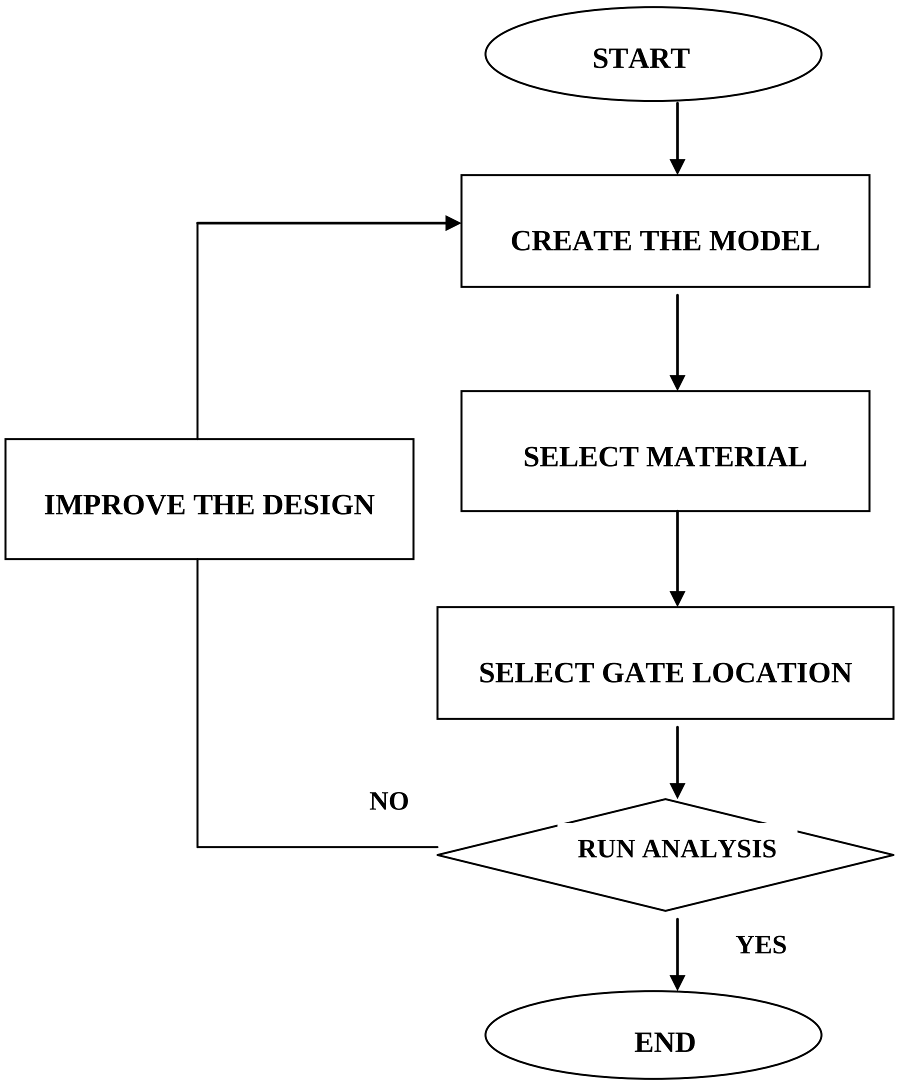



Figure 4.1 Moldflow Simulation Process

## 4.2 CREATE THE MODEL

In this study, two type of socket; existing socket and a modular socket created from the previous project are used. Existing socket have 3 parts (Figure 4.2) with different shape and function; part one (Figure 4.3) is the main part and it is an upper part for the socket. It is long and there is the place for 3 holes as a way for the 3 pin plug's leg and for the ON / OFF switch button. Part two (Figure 4.4) is shorter than the first part and it is function as a based part for the socket. This part's shape is designed as the place for 3 type wires that connected from the main electrical supply; earth wire (green), life wire (brown) and neutral wire (blue). All wire must be placed and connected properly to avoid short circuit. The last part for existing socket part three (Figure 4.5) and is the small one for other. It's placed at the end of part two and it's functional as a connected for based part (part two) and upper part (part one). Besides that, this part's functional as ways for the main wire before the wire was tighten at part two.

The second socket is modular socket (Figure 4.6) created from the previous project. This socket comes with two main parts. Part one for modular socket (Figure 4.7) is the upper part and the function for part one is same like existing socket; the place for 3 holes for the 3 pin plus's leg and for the ON / OFF switch button. The second part (Figure 4.8) is a based part and it is bigger than the first part. All wire that connected from the main electrical supply is placed here. Besides that, this part also has a space on the side of the body to allow this modular socket combined with other modular socket together.

All parts drawing are made from IDEAS part's modeler software and the detail drawing for all part referred from the real model with specific dimension. The 3 dimension drawing and exploded view for all sockets are shown in the figure below.

### 4.2.1 Existing Parts

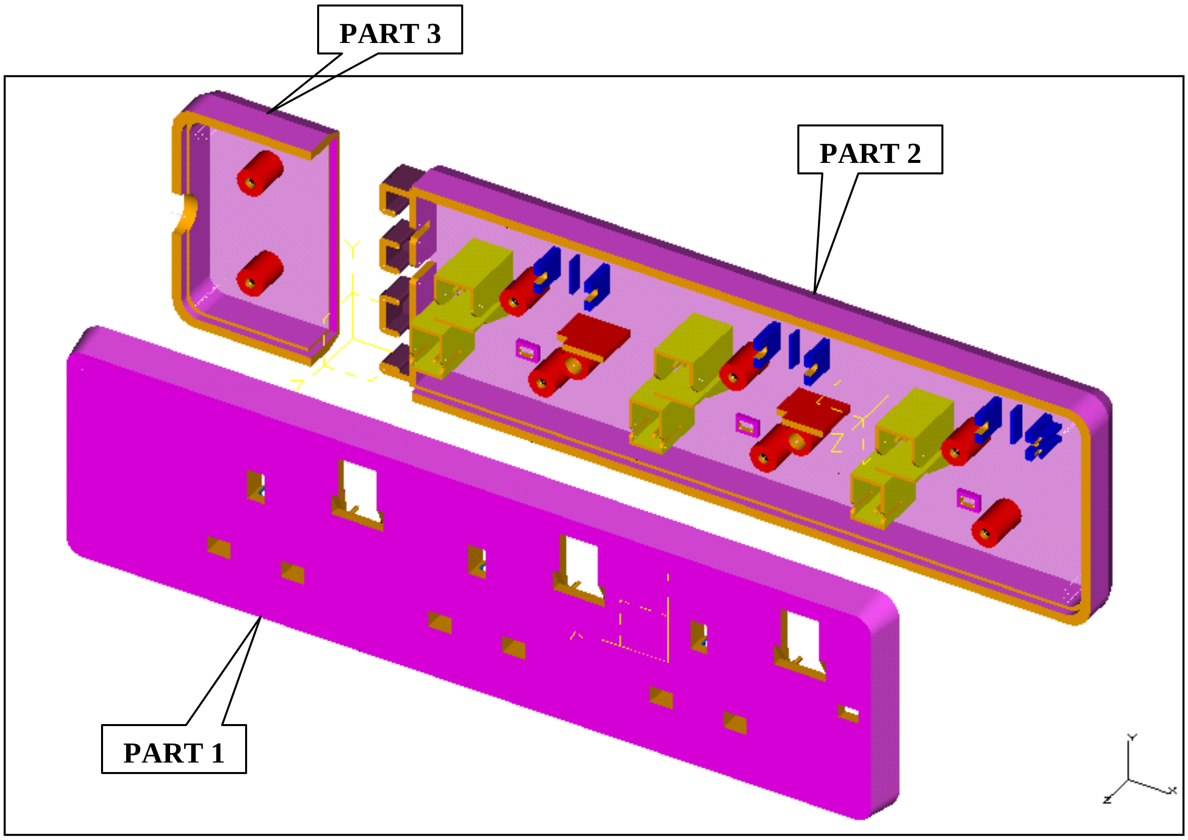



Figure 4.2 Existing Socket

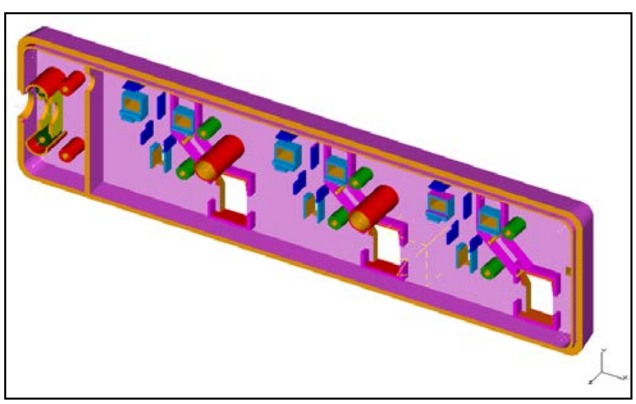


Figure 4.3 Part One