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"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design and Innovation)"

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Date : 30/6/2015

MOVING PART COMBINATION USING EFFORT FLOW ANALYSIS (EFA) TECHNIQUES.

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DECLARATION

"I hereby to declare that the work in this thesis entitle MOVING PART COMBINATION USING EFFORT FLOW ANALYSIS (EFA) TECHNIQUES is my own effort except for summaries and ideas which I have clarified their sources."

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To those who believe in me…..even when I didn't.

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ABSTRAK

Dalam projek ini, Effort Flow Analysis akan dilaksanakan ke atas ragum cengkaman playar. Ragum cengkaman playar yang sedia ada di pasaran lazimnya dibuat dalam komponen yang banyak dimana kos pembuatan dan masa pemasangan terbazir, dirnana faktor ini telah menyebabkan lahirnya evolusi ragum cengkaman playar untuk jurutera mereka pengelim mekanisme yang minimum komponen. Evolusi pengelim mekanisme dalam cadangan rekabentuk memberi peluang kepada industri pembuatan ragum cengkaman playar dalam kos pembuatan yang rendah dan penjimatan masa pekerja yang penting. Cadangan rekabentuk ragum cengkaman playar ini dapat berfungsi dan sesuai untuk pengguna. Sebelum Effort Flow Analysis dilaksanakan, pencarian maklumat tentang pengelim mekanisme mesti dilakukan untuk menentukan tujuan evolusi produk tersebut. Selepas Effort Flow Analysis dilaksanakan, rekabentuk akan diilhamkan berpandukan keputusan analisa tadi. Cadangan rekabentuk ragum cengkaman playar akan ditunjukan di dalam laporan serta akan membincangkan serba sedikit di dalam bab diskusi dan sedikit sebanyak akan membentangkan cadangan berkenaan dengan Effort Flow Analysis untuk dilakukan pada masa akan datang.

ABSTRACT

In this project, Effort Flow Analysis has been carried out by vise grip plier. The vise grip plier available in market are usually manufactured in many parts that is including manufacturing cost and assembly time have been wasted, this factor create opportunity the product evolution of vise grip plier for engineer to invent simple vise grip plier with minimized parts. The evolution of vise grip plier in a new proposed design creates an opportunity to manufacturing of crimping mechanism with low assembly cost and labor time saving which is very important to industry nowadays. The new proposed design is functional and very user friendly for customer. Before the Effort Flow Analysis has been done, preliminary finding of crimping mechanism parts must be implemented to determine the goal of product evolution. After the Effort Flow Analysis has been done, brainstorming on modeling is carried out, using the result of analysis as guidance. The proposed design will be shown and will be reported in report and will be discuss in discussion also stated a few recommendation about how this Effort Flow Analysis can be used in the future.

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INTRODUCTION

1.1 Project Background

Todays, a new manufacturing techniques have make a manufacturing companies to invested an outstanding deal of effort and resources. As the potential to improved product assembly time and affiliated profit margin have help DFA (Design for Assembly) into a business has drawn the attention in assembly and manufacturing. DFA (Design for Assembly) is an approach to designing with ease of assembly in mind. By making thing easier to assemble, one also makes the assembly process faster and more cost –efficient. In 1982, Boothroyd and his friend invented their manual of product design or assembly, lots of other research of DFA have contribute to this field.

By knowing, the traditional crimping mechanism can be hustle, where it so may parts, it is too much forces is needed to grip carefully and heavy than mobile phone because of the material steel. On the other hands, the manufactures one of the factors because it take a more time to manufacture the part of crimping mechanism as some parts can be eliminated to save the cost and production time. Therefore, the Effort Flow Analysis represent the transfer of effort through product components and reduction of device parts. By doing some analysis that has been done, the Boothroyd –Dewhurst DFA acts an important part to determine the effectiveness of new improvement of crimping mechanism.

1.2 Problem Statement

Most product are made of with many parts that cannot be combine due to design constrain. One of the reasons is that there having a relative motion between mating parts. Every single part contributed to the product cost. Many part count in a product will increased the material cost, manufacturing cost, assembly time and etc.
Common systematic DFMA methodology such as Boothroyd Dewhurst DFMA, Lucas DFA and Hitachi agreed that only mating parts with no relative motion can be combine. However using Effort Flow Analysis (EFA) techniques allows mating parts that having varying degree of relation motion to be combined.

1.3 Objective

1. To improve design of vise grip plier using Effort Flow Analysis by reduction parts.
2. To proposed a new design regarding after using the Effort Flow Analysis.

1.4 Scope

1. Literature review of Effort Flow Analysis
2. Gather information of crimping mechanism
   2.1 Modeling
   2.2 Analysis
   2.3 Parts information
   2.4 Dimension
3. Analysis the crimping mechanism using Effort Flow Analysis
4. Fabrication prototype for the new design.

1.5 Expected Outcome

1. Improve design and parts reduction of crimping mechanism.
2. Reliability of crimping mechanism on each part by using Finite Element Analysis.
3. Crimping mechanism with reducing assembly time and cost..

1.6 Project Flow Outcome

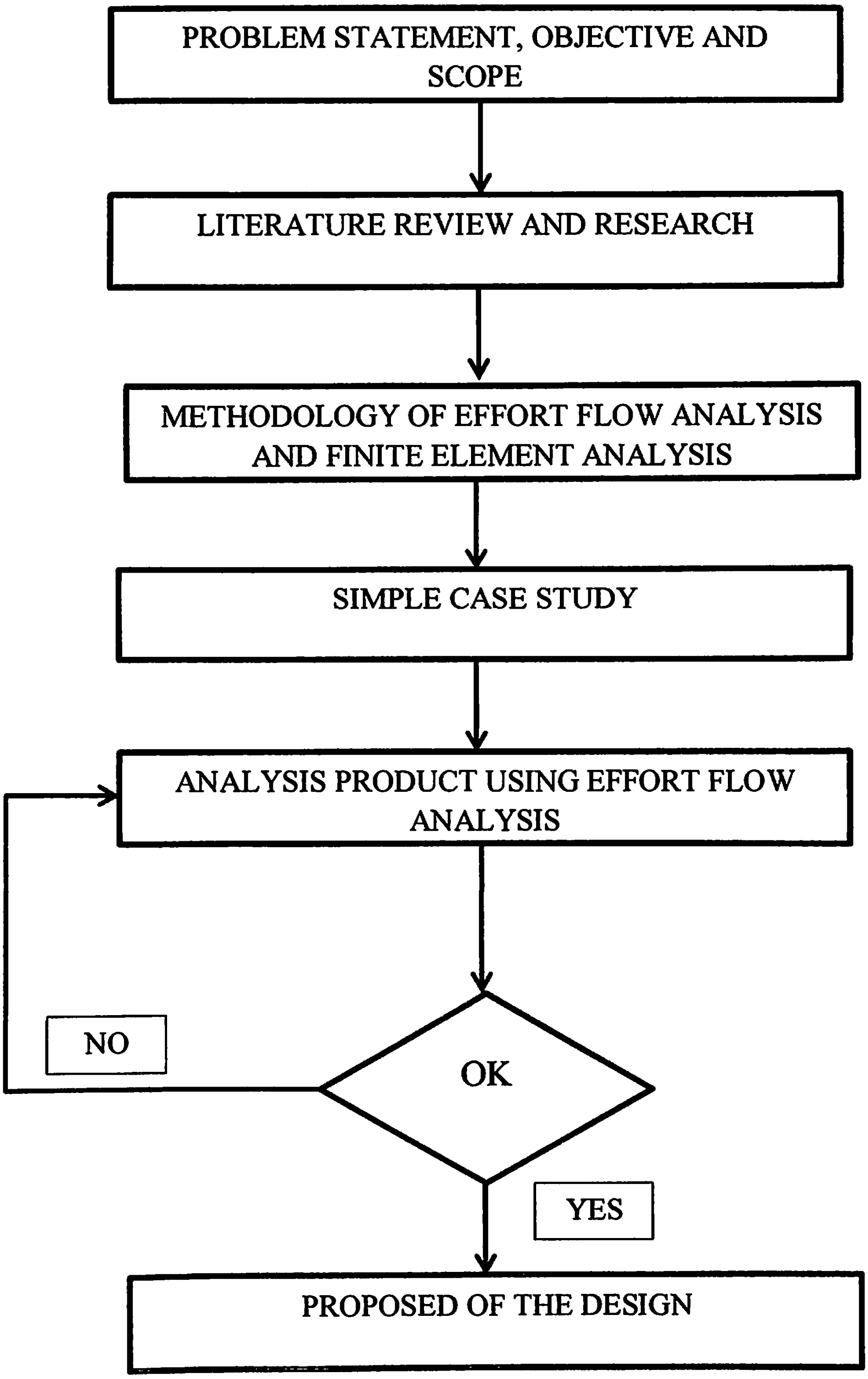

Figure 1.1: Project flow chart

1.7 Summary

The project background will be discuss in this chapter where every problem statement and introduction has been determine. Objective and scope also has been highlighted to cover on this project more clearly. Project Flow chart has been drafted to monitor in making this working project follow as schedule.

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will discussed detail about the Effort flow analysis. Effort flow analysis as a research topic has reached a level of maturity where it may be exported to industry for use in the directed change for the better, of interesting (old) objects in the domain of mechanical effort transmitters.

2.2 EFFORT FLOW ANALYSIS

Effort Flow analysis is one of efficient guide tools that can guide designer toward piece count decrease through part combination and relative motion (Greer and Wood, 2004). By detecting the component combination, the chances that are succeeded through static body or compliant mechanism enhance the advancement in products from mechanical energy field through analysis. Basically, the terminology had change to effort flow analysis as the sentence effort implies more liberal class of physical phenomenon than the force itself , therefore the Effort Flow Analysis is uses an effort flow diagram to interpret the transmission of effort through product components.

According to (Greer and Wood,2004) the effort flow analysis is a semantic network composed of nodes and links that are described using the fundamental of graph theory. The components of the product can be represent the diagram of nodes, while the links represents the interface between the components. The main benefits of modeling a product using flow diagram are to determine the possible components combination opportunities that has according to (Greer and Wood,2004).

The relative motion has been studied in several areas of engineering design and is of particular interest in effort low analysis. The fundamental information needed to apply effort flow analysis to product evaluation is captured in the interface description and represented in the effort flow diagrams by the links and their labels. The interface characterization is based on the type of relative motion that exist between the connected components. In effort flow analysis, there are a limited number of relative motion that exists between the connected components. The possible permutations as well as a naming convection adopted to describe them.

These opportunities are apparent when the relative motion at the interfaces between connected components is categorized. To identify relative motion characteristics across the link the labels are added to the links. Therefore the links are well-defined as follows:

i. 'N - Link': no relative motion between component.

ii. 'R - Link': relative motion at the interface and between other regions.

iii. 'C - Link': relative motion between the non-interfacial regions of component.

iv. '1 - Link': relative motion at the interfaces only.

These groups of components are the starting point for further analysis of component combination. Such as power flow analysis and functional modeling, effort flow analysis in the mechanical domain focuses on flow or effort (force or torque) through the product (Erdman, AG, Sandor, GN and Kota, 2001). Relative motion identifies locations within the product model where something interesting is happening. Relative motion denotes an easily identifiable characteristic of the interaction between the components of the product, and provides a convenient classification scheme for components and interfaces within the mechanical domain (Greer and Wood, 2004).

2.2.1 Relative motion guideline

The guidelines presented in this section represent the fundamental guidelines for the method. These guidelines use a classification scheme that is based on the relative motion characterization. The design guidelines are ordered hierarchically, beginning with the guideline that has the highlight like likelihood of achieving a successful component combination. The guideline hierarchy is stated as the order of the guideline (1st, 2nd, and Nth). The higher the order of the guideline, the lower the likelihood of success. The rationale for ranking each guideline is discussed in the guideline support sections.

The process for applying the design guideline is a feedback loop, where a guideline is applied, and the design concept that result is evaluated against the necessary for components combination. If the design concepts satisfy the necessary condition, the n the next guideline is applied to the now evolved product. If the necessary condition are not satisfied due to conflict between the customer needs and design concept, then the reason or the failure is determined. The next guideline is not applied until the necessary conditions have been satisfied, or the conflict is found to be irreconcilable, in which case the product is reverted back to the previous state.

In order to be joined directly, the components can interact between the two components can be represented by N-Link. As is well known quote N component typically provides the following functions that send business and allows DOF (degrees of freedom) for the installation and function-based material such as weight-bearing or heat transfer. Depending on the satisfaction of material and assembly / installation function is one of combinations of meaning. With this assumption is satisfied, the combination of N-Link is a function for sending business performance.

If the C-Link, can be represented by the interaction between the two components, the components can be incorporated directly into the bay mechanism to make changes to comply with the geometric parameters of the components involved (Greer and Wood, 2004). C- related components typically provide power transmitter function, the energy store / supply, enable DOF and functional materials based on solid and secure energy block. If the interaction between the two components can be represented by R-Link, the components can be incorporated directly into the mechanisms that comply with the original function of the relative movement can be provided through deformation of the components combined. Related R component typically provides the following functions: enable DOF and sent into force; and function is based on the main ingredient for controlling friction (Greer and Wood, 2004).

2.2.2 Solid Mechanics Criteria for Successful Components Combination

In order to redesign the product it must satisfy the original product function. Therefor the fundamental of physical laws must be abided. There are 3 solid mechanics laws that form basics or the fundamental functional criteria are given as follow:

1. Strain– displacement
2. Stress- strain law (material constitutive relationship)
3. Equation of equilibrium (force or stress)

To proposed the necessary functional conditions for component combination areas follows:

1. Degree- of – freedom condition: the original degree-of freedom based function must be sustained.
2. Energy transmission condition: the product is required to satisfy the energy transmission function for the material of the combined components.
3. Actuation force condition: the actuation force of the resulting rigid or compliant mechanism must be reasonable and successfully bounds of the actuating components.

In the original components, state of degrees of freedom is based on the premise that if the motion is provided. In addition, the motion-based functions of the components need to be maintained in some component designed. Mechanism, the motion has two basic requirements, firstly is the generation of the road, and the second is the end point position (Erdman, AG, Sandor, GN and Health, 2001)

Based on this model, the business will be through a combination of component material obtained from the analysis of trade flows and the strength of the combined components must be sufficient to provide the sender by energy (Wood and Otto, 1998). These criteria require the power of prayer and the satisfaction of the law stress-strain.

Balance and tension displacement law once again important. This is because of the power of moving the bounding relation to which Power has a minimum or maximum sensitivity reasons and for reasons achievability (Greer and Wood, 2004). Obviously there are material and geometry decisions to be made, the point of this example is to demonstrate the power of these simple guidelines to highlight opportunities and tools provided guidance for the systematic evolution of the product. For him to determine the potential benefits of the combination, and this appliance installation costs, in addition to issues o weight and aesthetics combine parts need to be assessed.

2.3 DESIGNS FOR ASSEMBLY (DFA)

DFA is a simple, structured analysis technique which gives design teams the information they need to reduce product costs by reducing the number of parts, optimizing manufacturing processes, simplifying parts handling, and improving product assembly

2.3.1 Boothroyd-Dewhurst DFA

Design for assembly (DFA) analyzes product designs to improve assembly ease and reduce assembly time (Boothroyd and Dewhurst, 1989). Often this is done through a reduction in part count and played an important role in reducing costs of manufacturing. It is apparent that for both manual and automated assembly, the effective methods to reduce assembly costs were those applied during design; manufacturing and production changes have less impact on product cost. The majority of commercial DFA methodologies developed in the last 15 years are applicable only during the embodiment design phase. The ability to apply DFA analysis at the conceptual design stage has been neglected. As a result, the DFA methods then force another iteration on the design, thus consuming time, material, and financial resources.

Developing product models based on the functional basis and applying the module heuristics, modular product architectures are developed and used for part count reduction at the conceptual design stage (Stone, McAdams, and Kayyalethkk, 2004). This method also leads to creative solutions for product designs, and in the cases studies presented here, a greater reduction in part count then was achieved using the Boothroyd and Dewhurst methodology. This method is easily implemented and used by a design engineer for any product. Additionally, the product architecture method works with other quantitative methods to determine assembly time information. This method leads to savings in time and resources.

2.3.2 Design for Assembly guidelines

Every process that have to do there will be a guidelines. Therefore, the guideline shown as follow :

1. **Simplify the design and reduce the number of parts**. This is because for each part there is chance or defective part and assembly error. The probability of a perfect product goes down exponentially as the number of parts increases.