UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOP PRODUCT SUSTAINABILITY IMPROVEMENT FOR AUTOMOTIVE PART: A CAR WIPER

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Design) with Honours.

By

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ABSTRACT

This project is a study of Design for Environment (DFE) and Design for Sustainability (DFS).

The objective of the project is to understand the concept of DFE and DFS as well as tools and methods used for Windshield wiper to be more sustainable and to identify its effect on the environment. Both of concepts are considered as a new design for ‘X’, therefore a very detail literature review on DFS and its tools are needed. Basically the literature review covers general background, key elements in the concepts, and methods used to practice DFE and DFS. Beside that the literature review includes study of the general background on windshield wiper like parts and system on windshields wiper. The project began with doing survey to car accessory shops and supermarkets to find a popular windshield wiper for proton waja to be a model. Two analysis bases on DFE and DFS were used to measure the bad impact for each part of windshield wiper to the environment. Before the analysis of DFE and DFS start, the type of material for all windshield wiper part must recognize by using X-ray diffraction machine. After that, software material selection (CES EduPack) has used to find the right material to replace the material of windshield wiper part which gives bad impact on the environment. Lastly, the final analysis using DFS (Solidwok Express sustainability) to make a comparison between the current material and new material in term of environmental
ABSTRAK

Projek ini merupakan satu kajian mengenai Design for Environment (DFE) dan Design for Sustainability (DFS).

Objektif projek ini adalah untuk memahami konsep DFE dan DFS serta alatan dan kaedah-kaedah yang digunakan untuk mereka satu "windshield wiper" supaya lebih tahan lama, serta megenalpasti kesanya pada alam. Kedua-dua konsep ini adalah cara rekabentuk yang agak baru, oleh sebab itu ulasan karya mengenainya and kaedah-kaedah yang digunakan akan dikaji. Ulasan karya ini meliputi latar belakang umum, unsur-unsur penting dan kaedah-kaedah yang digunakan untuk mempraktikkan DFE dan DFS. Selain itu, ulasan karya juga mengenai latar belakang "windshield wiper" seperti bahagian-bahagian dan system yang digunakan. Projek ini dimulakan dengan membuat tinjauan di kedai aksesori kereta dan pasaraya untuk mencari jenis windshield wiper bagi kereta proton waja untuk dijadikan model. Seterusnya dua analisis berkaitan DFE dan DFS digunakan untuk megukur kesan buruk pada setiap bahagian "windshield wiper" terhadap alam sekitar. Sebelum itu, mesin "X-Ray Diffraction" turut digunakan untuk megenalpasti jenis material pada model yang dipilih. Setelah megukur kesan buruk windshield wiper pada alam, analisis dari perisian "material selection" (CES EduPack) digunakan untuk mencari peganti pada bahan dari "windshield wiper" yang memberi kesan buruk pada alam supaya lebih mesra alam. Seterusnya, perbandingan antara bahan baru dan lama dinilai semula dengan menggunakan perisian dari DFS untuk mengkaji kesan material lama dan baru pada alam.
DEDICATION

Dedicated to my beloved family, Hj Abu b. Dollah and Hjh Daedah bte. Hassan, my brothers, my sisters and also to all my friends.

"THEY ARE THE INSPIRATION AND ENCOURAGEMENT FOR ME"
ACKNOWLEDGMENT

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<td>Design for Environment.</td>
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<td>DFS</td>
<td>Design for Sustainability.</td>
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<td>EMS</td>
<td>Environmental Management Systems.</td>
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<td>ISO</td>
<td>International Organization for Standardization.</td>
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<td>LCA</td>
<td>Life Cycle Assessment.</td>
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<td>SETAC</td>
<td>Society of Environmental Toxicology and Chemistry.</td>
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<td>SMEs</td>
<td>Small and Medium Enterprises.</td>
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<td>OICA</td>
<td>Organization of Motor Vehicle Manufacture.</td>
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<td>AEA</td>
<td>American Electronics Association.</td>
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<td>EPA</td>
<td>Environmental Protection Agency.</td>
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<td>REPA</td>
<td>Resources and Environmental Profile Analysis.</td>
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<td>CAD</td>
<td>Computer aided Design</td>
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<td>PP</td>
<td>Polypropylene</td>
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<td>UV</td>
<td>Ultra Violet</td>
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<td>XRD</td>
<td>X-Ray Diffraction</td>
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<td>NR</td>
<td>Natural Rubber</td>
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<tr>
<td>GWP</td>
<td>Global Warming Potential</td>
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<td>MJ</td>
<td>Mega Joules</td>
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<td>EVA</td>
<td>Ethylene Vinyl Acetate</td>
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CHAPTER 1

INTRODUCTION

In this chapter there are explanations on the project's background, objectives, problem statement, and also scope of this project.

1.1 Background.

Environmental hazards and disasters are global problems faced by the world. This condition is increasingly obvious and continues to occur despite widespread ways done to prevent it. Most of the countries in the world concern on issue of environmental pollution. Human play significant responsibility to take care of the importance of environmental quality, the situation worsened and increased each year. Pollutants come from various sources and entered through air, water and land with a variety of ways. Especially air pollutants come from motor vehicles, industries, and burning trash. Air pollutants can also caused by volcanic activity.

Waste from automotive part also can give bad effect to the environment. Increase total world production of cars every year cause additional waste from the automotive parts.
International Organization of Motor Vehicle Manufacture (OICA) was stated that in 2006 there were 49,886,549 passenger cars produced in the world, with increase of 6.45% over previous year.

In order to make world aware of the pollution issues and working to prevent it, "Design for Environment" is one of the approach way to avoid this problem. Design for Environment (DFE) refers to a systematic process to improve environmental performance of a product by changing the design (Vadim, 2004). Design for Environment is the systematic consideration during design, of issues associated environmental safety and health (Faksel, 1996). In line with the objective of DFE is to give a support to development environmentally friendly products (Betz et al., 2001).

"We do not inherit the earth from our ancestors we are, but instead we only borrow from our children and grandchildren .......", (Kevin, 2008). That part of the translation words Chief Seattle as a reference by the speakers and environmental activists around the world about the importance of environmental care is the responsibility of each resident in a country that does not damage the environment by indiscriminately in any way to avoid the effects of bad to future generations.

1.2 Problem Statement

Pollution caused by dumping things or materials resulting from human activities to natural environment. Pollution not only cause the world perish, it also threatens human health, plants, animals, and property damage. Waste from automotive parts also gives bad effect for environment because there are contain chemicals. For example waste from windshield wiper can also lead to contamination.

Nowadays, automotive industry becomes an important industry in Malaysia which contributes to economic development. Malaysia is one of a country that produces cars. Total production of the national car (proton) increases year by year due to the higher demand. From this situation, increasing of demands on car production will enhance the
production of windshield wiper. While we are proud to expand the automotive industry, we also need to correlate cars production with usage of wiper effect on the environment. Frequently, the conversion rate windshield wiper (wiper blades) is damaged once a year. Windshield Wiper are usually removed and replaced the old with the new. Effect of the addition waste will give bad impact on the environment indirectly. For example, wiper has been manufactured by molding a mixture consisting of rubber (polymer). This contamination can occur if it burned, buried, thrown in the river or sea. According to the Environmental Quality Act (1974) which stated that the contamination is no change either directly or indirectly to the physical properties, chemical, biological or radiation levels any part of the environment with the release, issued or put waste to affect beneficial uses, which gives rise to a dangerous situation or may be dangerous to health, safety or welfare of the public or other organisms, plants and animals.

1.3 Objective of The Project

i. Identify the principle of Design for Environment (DFE) and Design for Sustainability (DFS).

ii. To study the impacts of windshield wiper on the environment.

iii. To analyze the selected windshield wiper based on DFE and do product improvement.

1.4 Scope of The Project

The research emphasizes on the studies based on DFE and DFS as well as the tools and methods used for minimizing environmental effect on windshield wiper. This project was focusing on the application of product sustainability principles and DFE approaches in the wiper blades for Proton Waja.
CHAPTER 2

LITERATURE REVIEW

This chapter is to review the critical points of current knowledge and methodological approaches on a particular topic. Literature reviews are secondary sources, and as such, do not report any new or original experimental work.

2.1 Definition of Design

Design serves the larger aim of developing living and working environments (Dorst, 2003). Designers concerned about the actual production of their design possess. They have technical and fair knowledge on manufacturing processes. Besides that, knowledge of the right and honest use of materials is also very significant. This is because many materials only stand out well when used in special design (Fiell, 2001). Therefore designer also responsible to examine which characteristics of material reinforced the expressive qualities of the design, as well as which are the most efficient and constructive ways of using them without causing impact to the ecological system (Gogh, 2008).

According to Gogh (2008), the particular way in which a given culture shapes the present to enable the future is preserved in the Latin word ‘designare’, which means ‘to
designate’. This origin is often recognized in the word ‘design’ where both, in the Romance and Germanic languages, it refers to intentions, idea, draft and schema. All these concepts used to indicate a future state of affairs.

2.2 Definition of Environment.

Our environment is our surrounding. This includes living and non-living things around us. The non-living components of environment are land, water and air. The living components are germs, plants, animals and people. All plants and animals adjust to the environment in which they are born and live. A change in any component of the environment may cause discomfort and affect normal life. Any unfavorable change or degeneration in the environment is known as “Environmental Pollution”. We need to protect our environment to live happily.

In Medical Dictionary (2008) environment is defined as are sum of the total of the elements, factors and conditions in the surroundings which may have an impact on the development, action or survival of an organism or group of organisms.

Moreover, the environment comprises the circumstances, object or condition by which we are surrounded, not only the complex of physical, chemical, and biotic factor, but also the social and cultural condition that influence our lives and the life of our communities (Frumkim H., 2002).
2.3 Designs for Environment.

Design for the Environment (DFE) is an engineering design initiative that promotes environmentally sound decisions at every step of the production process from chemical design, process engineering, procurement practices, and product specification to post-use disposal. The concept is developing in the environmental/engineering fields and is beginning to gain public recognition. According to Fiksel (1996) Design for Environment is the systematic consideration during design, of issues associated environmental safety and health over the product life cycle as shown in Figure 2.1. DFE can be thought as a migration of traditional pollution prevention concept upstream into the development phase of products before production and usage.

![Product Life Cycle Recourses](image)

**Figure 2.1:** Product Life Cycle Recourses (Prof. Steven D. Eppinger MIT Sloan School of Management)

The goal of DFE is to enable design teams to create eco-efficient products without compromising their cost, quality, and schedule constraints (Fiksel, 1996). It must be integrated seamlessly into the development process; from the analysis of customer needs and establishment of product requirements to the verification these requirements have been fulfilled. The development process may be considered as “Design for X” where X
represents not only the environment but other parameters such as assembly and disassembly, compliance, manufacturability, reliability, serviceability and quality.

There is considerable synergy between some of these parameters, such as assembly and manufacturability, and DFE. DFE takes many product development aspects into account as shown in Figure 2.2 below.

![Diagram showing various aspects of DFE]

**Figure 2.2:** Product Development Aspect (Fiksel, 1996).

2.3.1 **Guideline of DFE.**

Guideline of DFE is a set of instructions or procedures which elaborate in detail the steps to be followed in the execution of a particular thing or process. The material extraction, production, and end of life are presented in Table 2.1, 2.2 and 2.3 respectively (Hari, 2003).
### 2.3.1.1 Materials Extraction.

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoid or minimize use of hazardous, toxic or in any other way...</td>
<td>Minimize toxic and/or hazardous emissions in later life stages and/or decrease harmful...</td>
</tr>
<tr>
<td><strong>Use materials which are renewable, recyclable and/or recycled, minimize use of thermosets or mixed polymers.</strong></td>
<td>Minimize the amount of non-renewable materials to be extracted from the earth.</td>
</tr>
<tr>
<td><strong>Design products in a way that reduces material use, use better design instead of over-dimensioning.</strong></td>
<td>Minimize the amount of materials to be extracted from the earth.</td>
</tr>
<tr>
<td><strong>Design for minimum waste production during production.</strong></td>
<td>Decrease amount of material wasted during production.</td>
</tr>
<tr>
<td><strong>Minimize number of materials used.</strong></td>
<td>Minimize recyclability and ease the sorting process.</td>
</tr>
</tbody>
</table>

### 2.3.1.2 Guide Line for Production.

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoid or minimize the use of hazardous, toxic or in any other way...</td>
<td>Minimize amount of harmful gaseous, liquid or solid emissions during production.</td>
</tr>
<tr>
<td><strong>Minimize and recycle residues and waste from production processes, within the</strong></td>
<td>Minimize amount of raw material required and the amount of waste created by</td>
</tr>
<tr>
<td>Guideline</td>
<td>Reason</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>manufacturing plant or outside it.</td>
<td>production processes.</td>
</tr>
<tr>
<td>Minimize use of energy-intensive process steps, such as high heating</td>
<td>Minimize the amount of energy used by the production processes.</td>
</tr>
<tr>
<td>differentials, heavy motors and extensive cooling.</td>
<td></td>
</tr>
<tr>
<td>Optimize use of heat exchangers and similar devices to utilize otherwise</td>
<td>Minimize of energy flows in production processes.</td>
</tr>
<tr>
<td>wasted heat.</td>
<td></td>
</tr>
<tr>
<td>Minimize losses from production facilities by good construction, service</td>
<td>Prevention of losses by leaks, oversized boilers and bad insulation.</td>
</tr>
<tr>
<td>and fast repair. Also provide maximum insulation of walls, pipes and</td>
<td></td>
</tr>
<tr>
<td>ceilings.</td>
<td></td>
</tr>
</tbody>
</table>

2.3.1.3 **Guideline for End of life, Design for Disassembly and Design for Recycling.**

Table 2.3: Guide for End of life, Design for Disassembly and Design for Recycling.

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulate possible reuse of the product by:</td>
<td>Extend possible lifetime of a product, therefore decreasing need for new</td>
</tr>
<tr>
<td>1. Classic design</td>
<td>products.</td>
</tr>
<tr>
<td>2. Sound constructions that does not become prematurely obsolete</td>
<td></td>
</tr>
<tr>
<td>technically.</td>
<td></td>
</tr>
<tr>
<td>Stimulate possible remanufacturing/refurbishing by:</td>
<td>Extend possible life time of part and components and therefore decrease need</td>
</tr>
<tr>
<td>1. Hierarchical and modular structure.</td>
<td>for new products.</td>
</tr>
</tbody>
</table>

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