DECLARATION

"I hereby declared that I have read through this thesis and found that it has comply the partial fulfillment for awarding the degree of Bachelor Mechanical Engineering (Design & Innovation)"

Signature : ……

Supervisor's Name : Mr. Ruzi Bin Hj. Harun

Date : MAY 2009

APPLICATION OF DESIGN FOR ENVIRONMENT IN PRODUCT DESIGN

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This thesis is submitted to the Faculty of Mechanical Engineering, in partial fulfillment of the partial requirement for Bachelor of Mechanical Engineering (Design & Innovation)

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"I hereby declared that this thesis is my original work except for questions and citations, which have been duly acknowledgment"

Signature : ……

Supervisor's name : Mohd Fariz Bin Sabtu

Date : MAY 2009

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DEDICATION

To my beloved family's

My love ones

All My friends

Lectures of FKM

Staff of UTeM

ABSTRACT

Today the idea of environmental issues influencing product design might seem as remote as a proposal in the early 1960's that pollution would become a constraint on manufacturing. For the main objective of Design for Environment is to give a support to develop environmentally friendly products. Thus, DFE must base on a very operative approach. A good DFE tool integrates environmental aspects directly in the product design process. So if anticipating change is a route to success, the method is use in term to solve the environmental effect. There are many methods available such as Life Cycle Assessment (LCA) method, BoothroydDewhurst (DFE) method and Material Flow Analysis (MFA) Method used in industrial. This report focuses on Boothroyd Dewhurst's (DFE) method that show how it works and applies to the environmental. The software is about Intended as an analysis tool that helps users design products that are easy to disassemble for recycling, reuse or disposal, the software has as its central premise the idea that voluntary environmental design should be a cost-driven activity. The software also help the company reduce cost and save time when make the research. This report include step of design for environmental in the Boothroyd Dewhurst's, design for assembly in Boothroyd Dewhurst's, re-design and generate a conceptual design and detail design using CAD software.

ABSTRAK

Masa kini idea untuk isu persekitaran banyak mempengaruhi dalam mereka bentuk semenjak pencemaran menjadi salah satu masalah dalam penghasilan produk. Objektif utama “Design for Environment” ialah member bantuan dalam mehasilkan produk yang mesra alam. Justeru itu, DFE mestilah beralaskan satu kaedah yang berhasil yand dapat dimanfaatkan. DFE bagus dalam mengintegrasikan aspek persekitaran terus kepada mereka bentuk hasilkan produk. Kita mengharapkan bahawa dengan mengunakan kaedah ini dapat menyelesaikan kesan pencemaran. Terdapat banyak kaedah yang boleh dipakai contohnya “Life Cycle Assessment (LCA) method”, “BoothroydDewhurst (DFE) method” dan “ Material Flow Analysis (MFA) Method” yang terdapat dalam penindustrian sekarang. Laporan ini lebih fokus kepada “Boothroyd Dewhurst’s (DFE) method” yang menunjukan bagaimana menyelesaikan masalah keatas persekitaran. Perisian ini memberi analisis kepada penguna dalam menentukan produk yang mudah dileraikan untuk kitar semula,diguna balik atau dilupuskan, Perisian ini membantu syarikat untuk mengurangkan kos dan masa dalam membuat penyelidikan. Laporan ini termasuk langkah – langkah pengunaan “design for environmental” ,“ design for assembly” dalam “Boothroyd Dewhurst’s. Terdapat juga mereka bentuk semula didalam perisian“CAD” dan konsep pemilihan reka bentuk produk.

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LIST OF SYMBOLS

DFA	**=**	**Design for Assembly**
DFE	**=**	**Design for Environment**
BD	**=**	**BOOTHHROYD DEWHURST**
MFA	**=**	**Material Flow Analysis**
LCA	**=**	**Life Cycle Assessment**
mm	**=**	**millimeters**
cm	**=**	**centimeter**
L	**=**	**liters**
m	**=**	**Mass (kg)**
t	**=**	**Time (s)**
Ib	**=**	**pound**
N_m	**=**	**Theoretical Minimum parts**
T_m	**=**	**Operation Time**
ABS	**=**	**Acrylonitrile-Butadiene-Styrene**
rij	**=**	**raw rating of concept *j* for the *i* th criterion**
Wi	**=**	**weighting for *i* th criteria**
n	**=**	**number of criteria**
Sj	**=**	**total score for concept *j***

CHAPTER 1

Introduction

1.1 Problem Statement

Design for Environment now is an important thing in production to develop and distribute pollution prevention and environmental to human health risk on alternative chemicals, processes, and products. The DFE program is a testing ground for new approaches to risk reduction through pollution prevention. This report are about to raise environmental awareness level among a designers and engineers with the DFE method.

1.2 Objective of project

The main objective is to reveals the associated cost benefit and environmental impacts of the product design.

1.3 Scopes of project

The scopes of project as listed below.

1. To study the other DFE methodologies that aid in environment – friendly product.
2. To study Boothroyd – Dewhurst (B-D) Design for Assembly (DFA) method.
3. To study B-D's DFE software.
4. To present how the B-D's DFE can be used to consider environmental factors in product designs.
5. To raise environmental awareness level among a designers and engineers.

1.4 Project Signification

The project divided into two different part, bachelor project 1 and bachelor project 2, because need to running the project in two semesters. Bachelor project 1 is about study the problem statement, study the methodology design for environment, specific method studies on DFE in Boothroyd – Dewhurst (B-D), and study on simple case study.

Bachelor project 2 more on re-design the product selected with using B-D DFA method, detail conceptual design, modeling by using CAD software and using software DFE . Figure 1.1 the flow of project planning for both bachelor projects. Gantt chart refers to the appendix 1.

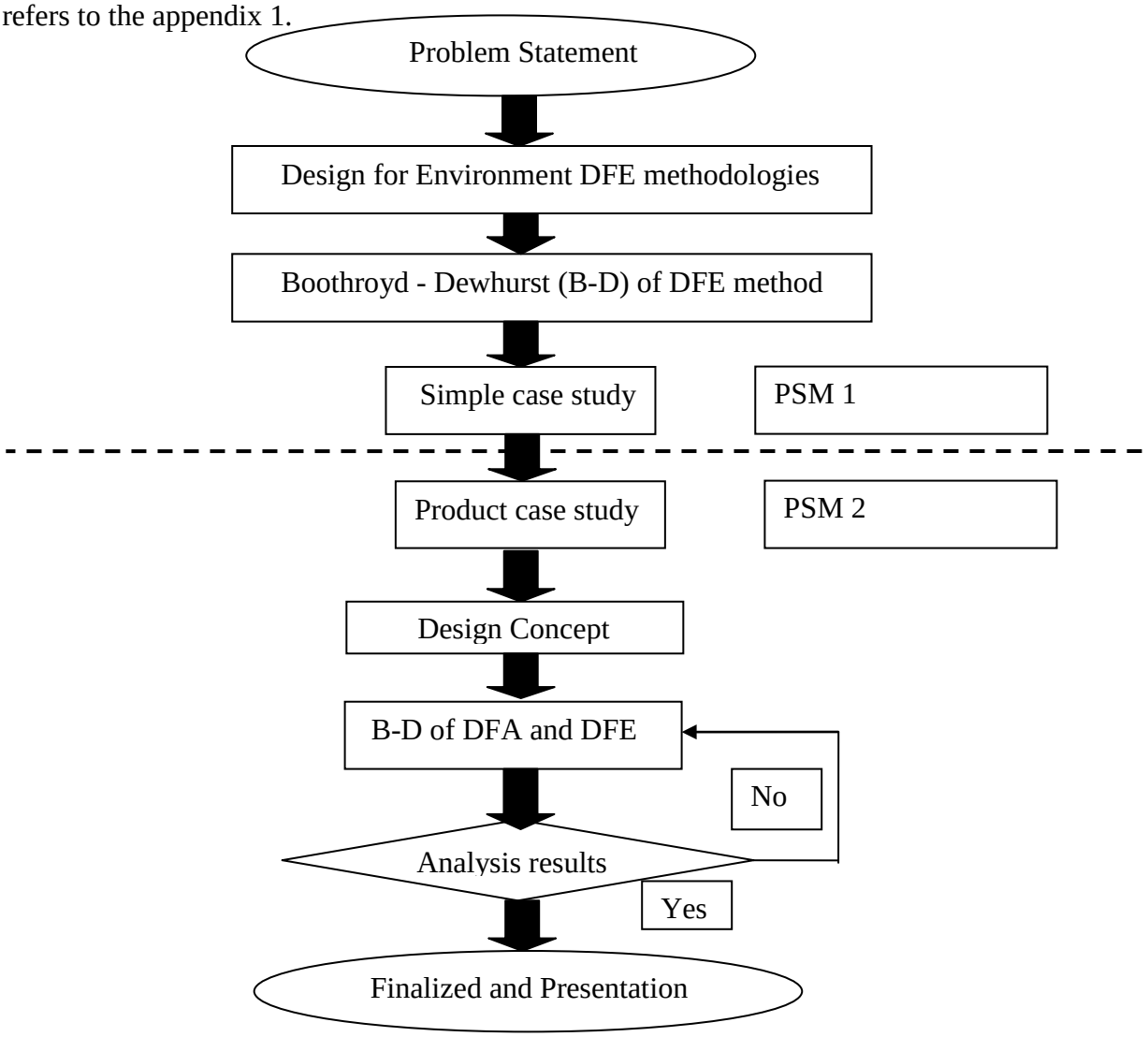

Figure 1.1 Flow Chart for bachelor project.

1.5 Summary

This chapter explained the introduction of the project. Project duration is two semesters for complete the project. Start from study the Design for Environment (DFE) methodologies, specific study on DFE methods in Boothroyd – Dewhurst (B-D) and to study the simple case study and product. DFE reveals the cost benefits for various options such as material recycling, part remanufacture or reuse, and disposal through landfill or incineration. In semester two, bachelor project will continue with redesign the selected existing product using DFE method, detail conceptual design, modeling by using CAD software and an analysis of the result that we get.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Design for Environment (DFE) is the consideration of pollution prevention and resource conservation within the design process. It was to recognize that environmental impacts must be considered during the new product design process, along with all of the usual design criteria. The purpose of DFE is to evaluate and identify ways to minimize the environmental burden resulting from products.

2.2 Design for Environment (DFE) methodologies

Over the past decade, Design for Environment (DFE) has attracted steadily increasing attention in the world. DFE is a general concept that refers to a variety of design approaches that attempt to reduce the overall environmental impact of a product, process or service, where environmental impacts are considered across its life cycle. DFE starts with the development of environmental goals within an example set of environmental policy, needs, and concern categories. Goals should be large in scope: considering the full life cycle of performance, cost, and environmental implications.

Within DFE, recyclability has received the most attention among design and manufacturing engineers in the U.S. Wide acceptance of design for assembly (DFA) methods provide a strong basis for including disassembly and recycling issues along with manufacturability evaluation. A product effectively designed for recyclability leads

to extended use of resources and net reduction in energy used to manufacture the product. The author also believes that recyclability is an issue to which design engineers can contribute environmental compatibility most readily as long as they have an appropriate end-of-life strategy. For this reason, the remainder of this paper focuses on environmental impact.

DFE, like predecessors Design for Manufacture & Assembly and Design for Service, is a concept-stage tool that substitutes analysis and optimization for the usual practice of following broad material and manufacturing guidelines. DFE reveals the cost benefits for various options such as material recycling, part remanufacture or reuse, and disposal through landfill or incineration. Designers also can pinpoint in the disassembly sequence where the major economic and ecological benefits end and where further disassembly is of no benefit either financially or environmentally. By understanding the inherent value of the materials and parts in a product, manufacturers are better able to plan for potential product take-back regulations [1].

DFE determines the environmental impact with a value-assessment metric developed by Boothroyd Dewhurst's European collaborator, TNO Institute of Industrial Technology, Delft, Netherlands. Called MET points, the metric analyzes issues relating to materials, energy, and toxicity.

The material assessment considers the product's impact on the exhaustion of earth's resources. The energy portion examines energy-related effects, such as the greenhouse effect, acidification, eutrophication, and smog. The toxicity factor measures toxic effects in terms of humans and ecotoxicity [1].

As questions in the disassembly and environmental sections of the software are answered, step by step change and improvement options are presented along with the product structure, costs, and eco effects. A graph display summarizes the entire product analysis and allows tracking of disassembly costs with environmental impacts.

2.3 Environmental Goals

The list of example facility, local, regional and global need for environmental goals is refer to the Tables 2.1 in appendix 2. To meet these environmental goals, DFE strategies include source reduction, material recovery, and when these fail, the use of treatable as opposed to untreatable materials. During design, these strategies can be introduced through:

- material selection/ changes,
- equipment selection/ changes improved purchasing choices,
- Improved operating practices,
- Improved recovery and disposition practices, and
- Improved logistics.

A useful technique to incorporate environmental considerations is to identify desirable types of technologies to be incorporated into designs. Table 2.2 in appendix 2 provides example technology types linked to DFE strategies. This example is not contributing to global warming, smog formation, etc. The application of technology within a design should be linked to DFE goal. As shown in Table 2.3 in appendix 2, a goal-impact-technology network can assist in DFE.

Desired and other technologies combine into design concepts. The *configuration status* refers to how these technologies are combined. In Table 2.4 below, show configuration status is intended to help the designer understand how complicated it will be to:

- Recover components and materials and
- Maintain and upgrade products and equipment.