



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DEVELOPMENT OF A FRAMEWORK FOR
REMANUFACTURING OF LCD MONITOR AT THE
DISPOSAL STAGE**

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

by

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This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design) (Hons.). The member of the supervisory is as follow:

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ABSTRAK

Setiap tahun, syarikat-syarikat pengeluar barangan elektronik banyak mengeluarkan produk-produk baru mereka ke pasaran, memperagakan kecanggihan produk mereka. Walaupun produk-produk tersebut banyak menonjolkan kemajuan yang penting dalam aspek teknologi dan kelengkapan antara muka pengguna (user interface), ini menyebabkan kelambakkan alat peranti yang lama dan tidak digunakan di persekitaran apabila pengguna memilih untuk membeli produk terbaru. Fenomena yang terkini ini meningkatkan lagi kadar pengeluaran kelengkapan barang elektrik dan elektronik di pasaran sama seperti yang dikatakan oleh Sthiannopkao dan Wing (2012), bahawa sebanyak 5 hingga 10% kadar peningkatan dicatatkan setiap tahun. Meskipun begitu, telah banyak inisiatif yang dilakukan oleh pelbagai pihak seperti pihak koperat, organisasi kerajaan mahupun bukan kerajaan, untuk menangani masalah pelambakkan barang buang yang baru ini seperti kitar semula. Walaubagaimanapun, kitar semula itu sendiri tidak mencukupi. Penyelesaian baru yang lain amat diperlukan. Salah satu cara adalah dengan cara pembuatan semula. Aktiviti pembuatan semula sisa e-waste yang sedia ada adalah amat sedikit. Justeru itu, adalah perlu untuk adanya rangkakerja pembuatan semula produk sisa elektronik. Objektif utama projek ini adalah untuk membantu membina satu rangkakerja untuk mengitar semula barang terbuang elektrik dan elektronik dengan menggunakan kaedah proses pembuatan semula. Kajian ini dilakukan adalah untuk mengenalpasti parameter yang mempengaruhi kitar semula dan pembuatan semula satu-satu produk. Tambahan lagi, kajian ini juga dilakukan bagi memahami dengan lebih jelas tentang pengurusan sisa terutama proses pembuatan semula yang berlaku di syarikat tempatan. Akhir sekali, adalah untuk membina satu rangkakerja berdasarkan infomasi yang diperolehi melalui pemerhatian yang dijalankan di syarikat tempatan dan daripada kajian literature. Akhir sekali, rangkakerja yang baharu tersebut dibuat perbandingan secara subjektif dengan product rangkakerja pembuatan semula yang sediaada bagi mengetahui kelebihan dan keberkesanan mereka.

ABSTRACT

Every year, electronic company launches several new products into the market, boasting around their technological advancement in their new product. Though the new product exhibit a significant improvement in terms of technology advancement and user interface, this creates an abundant of unused and outdated devices in the environment as consumer opt to buy the latest tech. This current phenomenon, greatly boost the rate of disposal of electrical and electronic equipment (EEE) which according to Sthiannopkao and Wing (2012), a 5 to 10% increase of e-waste is detected annually. However, many initiatives has been done be it by cooperate, government and non-government organization to help curb this rising new type of waste. For example recycling. But recycling alone is not enough thus a need to for other ways of improving the method. One way is through remanufacturing. Existing remanufacturing activity of e-waste is almost non-existent therefore the need for a framework of remanufacturing for the e-waste product. Thus the main objective of this project is to construct a framework for remanufacturing an electronic product waste at the disposal stage. This study is done to determine the parameters affecting recycling and remanufacturing of a product. In addition, this study also was conducted to get a better understanding of waste management especially remanufacturing process occur in the local company. Lastly, with the construction of the remanufacturing framework based from the information obtained from an observation conducted at a local company and literature findings Finally, the new remanufacturing framework was compare subjectively with other existing remanufacturing framework for an electronic product to assess its effectiveness and advantages it possess.

DEDICATION

To my beloved parents

Supporting family

Respected supervisor

Helpful friends

Manufacturing Engineering Faculty

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

AP	-	Associated Professor
BLU	-	Back Light Unit
DfE	-	Design for Environment
DfRem	-	Design for Remanufacture
DfX	-	Design For X
FYP 1	-	Final Year Project 1
FYP 2	-	Final Year Project 2
LCD	-	Liquid Crystal Display
OEM	-	Original Equipment Manufacturer
OHL	-	Oakdene Hollins Ltd.
OTA	-	Office of the Technology Assessment
PCB	-	Printed Circuit Board
PSM 1	-	Projek Sarjana Muda 1
PSM 2	-	Projek Sarjana Muda 2
StEP	-	Solving the E-Waste Problem
UK	-	United Kingdom
UN	-	United Nation
WEEE	-	Waste of Electric and Electronic Equipment

CHAPTER 1

INTRODUCTION

As an introduction, this chapter explains the background of the project such as the project title which is the “Development of a framework for remanufacturing of LCD Monitor at the disposal stage”. The problem statements, the objectives of the project and the scope of the project is also briefly explained.

1.1 BACKGROUND

Recycling electrical and electronic waste involves several process steps which primarily consist of segregation, cleaning, and processing of the separated parts (e.g. melting, chemical bath, shredding and etc.). Different products may utilize different stages of recycling process and some even more stages of processes. For a mobile devices for instance, a mobile phone is separated into several components; batteries, plastics, circuit board and other accessories (Mobilemuster, 2015). Each of the component gets cleans and goes through further processing to be extracted of their core chemical element. Those core elements can be used to produce other product. That is basically the overview process of recycling.

The waste of electric and electronic equipment (WEEE) is one the many waste that is generated widely around the world. (StEP), a Solving the E-Waste Problem (StEP) Initiative – a partnership of United Nations (UN) organizations, industry, governments, non-government and scientific organizations, collaborative organization for solving the –e-waste problem, states that ‘e-waste is a general condition, it can be taken to cover TVs, data processors, mobile phones, white goods (e.g. Electric refrigerators, washing machines, dryers, etc.), home entertainment and stereo systems, toys, toasters, kettles – almost any house or business item with circuitry or electrical elements with power or battery supply. Nearly all third world and developing countries generate this sort of waste though it is not every bit much as the ones off from the developed country such as the United Kingdom (UK) and Japan. To tackle this issue, a process called remanufacturing will be used in this project.

Remanufacturing is the procedure of restoring broken product assemblies to a new like produced in a operational state by rebuilding and replacing the parts (Ijomah et al., 1999). According to Lund. (1998) remanufacturing is a restoration of a used product to a like new condition with respect to quality by replacing components or reprocessing used parts. The term remanufacturing has been used since the 1942 with the successful implementation of in Jasper Engine and Transmissions Company founded by Alvin C. Ruxter. From then forward, the process is constantly being improved to better suit the different fields of products. Nowadays, the term remanufacture has been enlarged; in order to make out with the growing problem of e-waste, many people began to believe that there is a need to design for remanufacture (DfRem) the electronic product. In this report, the design of framework to reuse electronic waste through remanufacturing at the disposal stage is delivered.

1.2 PROBLEM STATEMENT

One of the garbage waste that is increasing in volume is the electric and electronic waste or e-waste. With each year, electronic companies launch several new product, more electric and electronic waste are generated as the user opt for a newer product. If this trends continues, the electric and electronic waste will be one of the highest waste generated in the coming years. With the e-waste volume increasing at the rate of 5 to 10% annually according to Sthiannopkao and Wing (2012) a major change in the method of assessing the e-waste has to be made. Within the recent years a major growth in e-waste generation has also seen in developing countries like China and India. Despite Malaysia having a very low quantity of e-waste produced, it will prove to be handful to handle if no appropriate measure is taken. (Suja et al., 2014) Current remanufacturing activity for high value end of life product has been done for quite some time but not for the e-waste. It is due to this fact that a solution for solving the e-waste crisis needs to be address by means of developing a framework to recycle the e-waste generated using remanufacture.

1.3 OBJECTIVE

The aim of this research is to develop a framework for remanufacturing of LCD Monitor at the disposal stage.

This can be accomplish by following these objectives:

- i. To identify all the parameters in remanufacturing a product through literature review.
- ii. To conduct an observation in one local remanufacturer company
- iii. To construct and analyze the propose framework for an LCD Monitor to assess its potential to remanufacture via comparing with existing framework of remanufacture of other product.

1.4 SCOPE OF PROJECT

This project consist of conducting an industrial visit to a local recycling and remanufacturing company to make an observation in order to help in identifying the factors affecting remanufacturability of a product. The observation are mainly focus towards the recycling and remanufacturing activity done in the company. In addition, a literature review of the parameters of remanufacturing will be done to further enhance my understanding on the overall process. All the collected data, are to be analyzed in helping to understand the process in remanufacturing. With the observations and the literature review on the factors affecting the remanufacturing process a new framework for remanufacturing of LCD Monitor will be constructed.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapters contains the literature review of this study which related to the scope of the study. The research also being conduct based on the journal, thesis, technical document, books, case studies reports and also electronic - media sources. All these sources was selected based on similarity with the scope of study. All the sources must related to the customer design preferences. This chapter also includes Remanufacturing, and Design for Remanufacturing for further study on product preferences. Toward the end of this chapter, the elements will be narrowed down to the situation in the remanufacturing industry and the e-waste.

2.2 Remanufacturing

Remanufacturing is a process of restoring a product at the end of their life cycle into a like-new condition through numerous steps of remanufacture. Apparently, there is no agreeable definition of remanufacturing. This may be due to conflicting ideas and concept of two different terms; reuse and refurbishing. These terms can be distinguished from each other as follows:

- Repairing: to put something that is damaged, broken, or not functioning correctly, back into good condition or make it work again. (Cambridge Dictionary)
- Reusing: The simple reuse of a product with no modification

- Refurbishing: The largely aesthetic improvement of a product which may involve making it look like new, with limited functionality improvements
- Reconditioning: The potential adjustment of components, bringing an item back to operating order, although not necessarily to an ‘as new’ state.
- Recycling : The extraction of a product which are easily constructed and have minimal numbers of components (Ijomah, 1999).
- Remanufacturing: A series of remanufacturing steps acting in an end-life part or product in order to return it to like-new or better performance, with a warranty to match (catching Design Ltd., 2015).

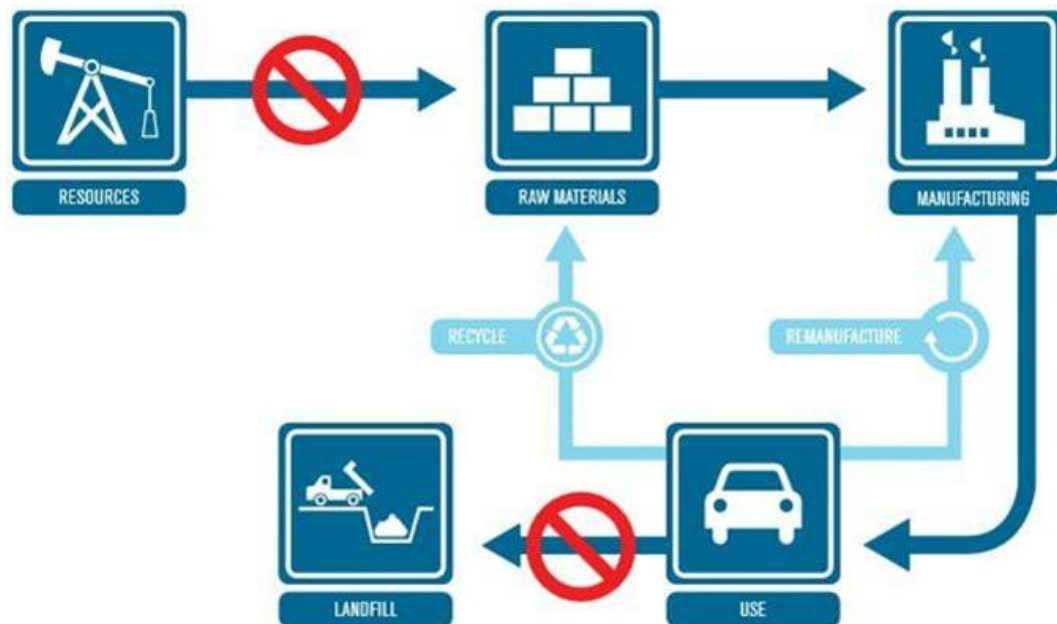


Figure 2.1: The Ideal resource efficiency system (Preston, 2015)

Figure 2.1 shows the ideal resource efficiency system, with an entirely circular economy being created through both recycling and remanufacturing, where nothing is wasted and no new resources need to be applied.

According to Lund. (1983), remanufacturing is defined as a process of putting parts together old products into new ones whereby the new parts are used to produce fully functional or a better quality than the original product. Remanufacturing has a totally different definition to that of repair operations, since it has several different processes that requires for a product to go through. Inspection, disassembly, cleaning, reprocessing, reassembling, and testing (Hatcher et al., 2013).

Haynesworth and Lyons (1987) published their own definitions of remanufacturing described, as a process of bringing back to life of an old product to a like-new condition via replacing and rebuilding its component parts. Many of the well-known researchers such as Lund (1984), Amezcua et al. (1996) and Guide (1999), agree to Haynesworth and Lyons definition; showcasing similar meaning of remanufacturing in their papers. It's a little different for some other researchers like Krupp (1992), he define remanufacturing as a "Rebuilding or Refurbishing". The problem with this definition is that, refurbishing is used to describe a range of operations that are used to reclaim used products including repair and reconditioning (Ijomah, 2002).

Despite all this confusion in the exact definition of remanufacturing there are four ways to differentiate remanufacturing from repair, and reconditioning (Ijomah, 2010). The four ways are as follows:-

- a. Remanufactured products have a longer warranty period compared to the ones from a repaired and reconditioned products. In repaired, the warranty is applied to those of the repair components. In reconditioning, warranty is only given to the worn out parts. On the contrary, the warranty in remanufactured products includes all of the parts of the product.
- b. Since remanufacturing involves in greater work job, remanufactured products are actually have a higher level of quality and performance than repaired or reconditioned products.
- c. Through remanufacturing, products will loose their originality when the parts undergo checking and any known parts that cannot be remanufactured is replaced with a new components. Nevertheless, repair and reconditioning, products keeps their identity.
- d. A products that has been repaired or reconditioned may not usually received any component upgrade, whereas a remanufactured products may involve one or more upgrades.

According to Ijomah (2010) also, the difference between remanufacturing and recycling is due to the quality problem. Designers does not favour to work with material that may be of lower quality, which can reduce profit margin.

2.3 Design for Remanufacture

Design for remanufacture is the one of the research field for remanufacture when (Hatcher, 2011) states that whether a product is good for remanufacture or not significantly influence by the decision done during the product design process. There are specific product characteristics that may be suitable to be used in particular remanufacturing process steps, such as disassembly or cleaning. Researchers started to recognize the concept of design for remanufacture as a design activity when many of the technical challenges to remanufacture can be related back to how the product was designed (Ijomah et al., 2007a,b). The importance in considering remanufacturing issues in product design has regularly been mentioned to in the literature. Improving remanufacturability through design may reduce the cost of remanufacture, making it a more doable and lucrative product end-of-life strategy.

With all the fuss about the importance of it, one must wonder, what exactly design for remanufacturing? From a perspective of researchers, a variety of definition is presented in this literature review. For instance: (Shu and Flowers, 1999) have stated that DfRem is a product design that facilitates any of the steps involved in remanufacture. However (Nasr and Thurston, 2006) said that it is a process of considering the product strategy (marketing, reverse logistics) and the detail engineering of the product in terms of remanufacture. According to (Charter and Gray, 2008), it is a combination of design process whereby an item is designed to facilitate remanufacture. All of the description provide a broad view of what DfRem is. In all of the description, it is agreed upon that the aim of DfRem is to enhance remanufacturability. To achieve that, designers must actively consider each remanufacturing steps or issue and implement it at the early stage of product development. DfRem as view from the concurrent engineering is regard as one of the element in design for X (DfX), in this case X being remanufacture.