CHAPTER

11

DESIGN FOR DISASSEMBLY IN RICE COOKER MANUFACTURING

Cheng Siew Min, Tengku Nur Azila Raja Mamat, Muhammad Farid Shaari, and Safian Sharif

11.1 INTRODUCTION

Design for disassembly (DFD) is the method applied to design the product disassembles easily for repair, maintenance and reuse of material that can lead to reducing the impact on the environment at the product end of life (EOL) (Mule, 2012). The product components that implement the DFD concept in design specifications are better suited for reuse, remanufacture and recycling (Shetty & Ali, 2015). Eco-design approaches such as DFD guide designers in designing easy products to disassemble by giving a set of rules and principles. DFD makes a proficient de-manufacturing plan of components, and it reflects product components with a high value, which can be divided from the others for reusing, recycling, or remanufacturing (Cui & Jørgen Roven, 2011). When reusability and recyclability have increased, many resources will be saved up as well, and the valuable lifetime of products and functional units extend (Tanskanen, 2013).

The rice cooker is one of our society's most popular household appliances. However, when broken, its complexity makes it difficult for

users to disassemble and repair, which tends to reject the repair of the broken parts. Once products reach their EOL, most of them are dumped as e-waste, leading to the formation of landfills (Suja et al., 2014). E-waste is one of the fastest-rising waste streams in our society nowadays (Widmer et al., 2005). E-waste will significantly result in environmental pollution, change the landscape and affect ill health if improperly handled (Babington et al., 2010).

This study aims to propose a simple structure for the rice cooker for household usage, which focuses on the mechanical part so that it can be disassembled easily for repair or removal without the assistance of tooling. Implementing the DFD concept into the product design specification enables the components of the product to be better suited for reuse, repair, or recycling (Raja Ghazilla et al., 2015). The result of this study will benefit society since the rice cooker can be disassembled and separated easily in a shorter time. The efficient and simple design of the rice cooker leads to labour costs and time-saving due to its ease of dismantling and access. The products designed for disassembly can deliver much more significant savings and bring benefits through remanufacturing from the reuse of resources (Soh et al., 2014). Remanufacturing is a valuable way to bring a product back to its life cycle, consequently freed from landfill (Alias et al., 2014).

11.2 PRODUCT LIFE CYCLE

A product's life cycle starts from raw material extraction due to market needs (Herrmann et al., 2008). The raw materials such as iron, copper, aluminium, platinum and critical elements are commonly found in EEE. These materials and elements are excavated from the earth and processed to manufacture the products. The manufacturers have a high impact on the environment and should play a significant role in fulfilling the requirements of consumers at the same time. It should be noted that sustainable development involves environmental protection and significant economic issues. During the design and manufacturing process, the designer should apply the principle of DFD to the design.

Introducing disassembly systems aims to "close the loop" of a product's life cycle. Modifications must be made between the requirements and the actual possibilities, considering the environmental requirements for production in the current technology and economy. There is a need for a comprehensive disassembly strategy concerning the recovery of industrial goods.

11.3 PRINCIPLE OF DESIGN FOR DISASSEMBLY

Products designed for disassembly are more serviceable for users and aid in maintenance and reparability. The designers must consider the critical factors of DFD so that the product subassemblies can be easily disassembled, reused, or remanufactured, and they can reduce environmental impact at the end of the product's life. DFD guidelines have allowed designers to integrate disassembled thoughts during product design. There are three fundamental requirements in the context of DFD: material selection, fasteners and connections selection, product structure and component design (Shalaby & Saitou, 2008). The rest of the factors are characteristics of components for disassembly conditions (Bogue, 2007).

11.4 FINITE ELEMENT ANALYSIS

The finite element method can also be stated as finite element analysis (FEA), an essential computational technique for designing and analysing complex real-life problem situations (Chakrabarty et al., 2016). A 3D model has to be constructed to specify the material properties for every part of the model before FEA modelling. The physical effects applied to the model were recognised to specify the analysis type and element types correctly. According to the type of physical effects being studied, the field variables may contain the temperature, stress, displacement, strain and heat flux (Seshu, 2003).