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DESIGN AND DEVELOPMENT OF AN AUTOMATED SORTING SYSTEM IN  
MANUFACTURING INDUSTRIES

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This report was adduced as  
fulfilling a part of requirement for award of  
Bachelor Degree of Mechanical Engineering (Design & Innovation)

Faculty of Mechanical Engineering  
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APRIL 2010

“I hereby declared that this dissertation entitled  
‘Design and Development of an Automated Sorting System in Manufacturing Industries’  
is the result of my own effort except as cited in references.”

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For my beloved mother and father

## ACKNOWLEDGEMENT

Many thanks to my project supervisor, Mr. Shafizal bin Mat for his guidance, motivation, advice, ideas and time that helps me in this project for this final year project.

I owe a debt of thanks to all whose time, concern and effort were given during the process of conducting the project. A special note of thanks is also to the coordinator of PSM and all of FKM's lecturers and staffs.

Special thanks to Universiti Teknikal Malaysia Melaka (UTeM) that has given me the opportunity to further my study in bachelor degree of mechanical engineering and allow me to complete my study in four years period. Not to forget to all of lecturers and staffs of UTeM that has given me valuable education and experience that will be very important in my life.

Best regard also to everyone whose involve directly or indirectly to make sure this project were going on successfully.

## ABSTRACT

Design and development of the automated sorting system in manufacturing industries for plastic recycling was done by conducting research on the method of identification plastic types and sorting mechanism. Plastic that usually used can be categorized into seven types. There are two main types of sorting system which are macrosorting and microsorting. Research methodology for this project also has been explained. Methods used to perform research are archival collection including online and library research. Besides, methods to design and analysis the proposed design by using CATIA software also stated. In order to achieve the objectives of the project, the studies and research on the existing designs of the automated sorting system for plastic recycling were done. The advantages and disadvantages of each existing design were reviewed and the data will be used for development of a new design. The design process is started by concept generation and selection. The conceptual designs produced are selected by using concept screening. Concept design selected then been continued for development of detail design by using CATIA software. The detail design is analysis is Generative Structural Analysis workbench in CATIA to find the Von Mises stress and determine the factor of safety. The proposed design has saved about 92 percent of space usage compare to the existing design. The proposed design is compared to the existing design to find out the advantages and disadvantages of the proposed design. Design optimization also been explained in the discussion section.

## ABSTRAK

Rekabentuk dan pembangunan sistem pengisihan secara automatik dalam industri pembuatan untuk kitar semula plastik telah dilakukan dengan menjalankan kajian ke atas kaedah-kaedah pengenpastian jenis-jenis plastik dan mekanisme pengisihan. Plastik yang biasa digunakan boleh dikategorikan kepada tujuh jenis. Terdapat dua jenis sistem pengisihan iaitu *macrosorting* dan *microsorting*. Kaedah kajian untuk menjalankan projek ini turut diterangkan. Kaedah-kaedah untuk menjalankan kajian ialah pencarian arkib. Selain itu, kaedah merekabentuk dan menganalisis rekabentuk yang dicadangkan menggunakan perisian lukisan berbantu komputer dan perisian kejuruteraan berbantu komputer turut dinyatakan. Untuk mencapai objektif projek, kajian dan penyelidikan telah dijalankan ke atas rekabentuk sistem pengisihan secara automatik yang sedia ada. Kelebihan dan kekurangan bagi setiap rekabentuk sedia ada akan dinilai dan data yang diperolehi akan digunakan untuk pembangunan rekabentuk yang baru. Proses rekabentuk bermula dengan menjana rekabentuk konsep diikuti dengan pemilihan rekabentuk konsep. Rekabentuk yang dipilih kemudian akan diteruskan kepada rekabentuk terperinci dengan menggunakan perisian CATIA. Analisis dijalankan ke atas rekabentuk terperinci tersebut untuk mendapatkan tekanan Von Mises dan faktor keselamatan. Rekabentuk yang dicadangkan telah menjimatkan sebanyak 92 peratus penggunaan ruang dibandingkan dengan rekabentuk asal. Rekabentuk yang dicadangkan akan dibandingkan dengan rekabentuk sedia ada untuk mengetahui kelebihan dan kekurangan kepada rekabentuk yang dicadangkan. Optimasi rekabentuk juga akan diterangkan di bahagian perbincangan.

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**LIST OF SYMBOLS**

PET	=	Polyethylene terephthalate
HDPE	=	High-density polyethylene
V	=	Vinyl
LDPE	=	Low-density polyethylene
PP	=	Polypropylene
PS	=	Polystyrene
t/h	=	tone per hour
HP	=	Horse Power
$\omega$	=	Angular speed
rpm	=	Revolution per minute
$v$	=	Linear velocity
$r$	=	radius
$m$	=	meter
$s$	=	second
$g$	=	gram
$kg$	=	kilogram
$F$	=	Force applied

m	=	Mass
a	=	Acceleration
$u$	=	initial velocity
t	=	time
N	=	Newton
P	=	Pressure
A	=	Area
Pa	=	Pascal
FoS	=	Factor of Safety
ms	=	milisecond

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## CHAPTER I

### INTRODUCTION

#### 1.1 Background

Sorting system is a process to separate mixed items into predetermine types. This process can be done manually human power or by automated system. For sorting of plastic recyclable, it can be done manual and automated. Manual sorting relies to the man who visually identifies and picks out the plastic. While automated sorting system uses the several machines and devices to perform the task.

Automated sorting system uses a detection system or combination of detecting system to identify the different types of plastic. The plastics need to be sorted into their resin types. This is because; the process of recycling the plastics will be done by the type of resin and must not be mixed with other types.

Automated sorting system for plastic recycling can be done either by whole bottle sorting (macrosorting) or flake sorting (microsorting). Each type has several methods that can be used. For macrosorting the methods that can be used are spectroscopy, x-rays, laser aided-identification and marker system. While the methods for microsorting are sink float system, froth flotation and selective dissolution and flash devolittization.

## 1.2 Objectives

This project has a few objectives that need to be achieved. The objectives of this project are as follow:

- i. To design and develop an automated sorting system in manufacturing industries of plastics for recycling.
- ii. To optimize the dimensions and space requirement for propose design.

## 1.3 SCOPE

This project will be covered several scopes including:

- i. Literature review on the automated sorting system in manufacturing industries of plastics for recycling.
- ii. Analyze existing design of the automated sorting system.
- iii. Conceptual design of the automated sorting system.
- iv. Selection of the concept design.
- v. Detail design of the automated sorting system.
- vi. Analysis of the detail design.
- vii. Compare between the existing and proposed design.

## 1.4 Problem Statement

Process of recycling of plastics need to be done into resin categories. Plastics containers that want to be recycled need to be sorted first into their resin types. They can be sorted manually by hand but it is quite costly to hire labours and less efficient. Therefore, automated sorting system of plastics for recycling can be the solution to sort the plastics for recycles in a lot of amount.

The automated sorting system of plastics for recycle has already existed in the industries. There are several methods of sorting used by the existing system. Some systems may have very high-tech sorting methods. While others use simpler ones. In this case, the performance of the automated sorting systems may vary to each other. For the high-tech system, the sorting performance may be higher but it could increase the cost of conducting the system because the power consumption and implementing cost.

Meanwhile, some existing systems have a big structure. This might caused the space uses to install the system become larger. More space used to locate machineries of the system. Thus, the propose design of the system is focus on low to medium size of recycling industry. The proposed design need to be less spacious but not sacrifices the performance of the system.

## 1.5 Dissertation outline

### Chapter 1: Introduction

This chapter gives the explanation about the introduction of this project. It covers background, objectives, scopes and problem statement of the project.

### Chapter 2: Literature Review

Literature review done is covered on the searching of past research and project that related to this topic. Related journals, books and article have become the main sources to collect the important information. Beside that, the online source from internet also has been used for this chapter. Other sources of information are gathering from patent, pamphlet, brochure and product catalogue.

### Chapter 3: Research Methodology

In this chapter, all methods in theory and practical that been used in this project will be explained. There are several methods used in to perform the research for this project. The research method that been used are archival research, online research and existing design and system research.

### Chapter 4: Analysis of existing design

There a several existing design of automated sorting system for plastic recycling in the industries. The design of the system may have few differences among each other. Thus, analysis needs to be done to the existing design to find the advantages and disadvantages among them. Then the result can be used to further the studies on this project.