UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF A CONCEPT FOR PHYSICAL RECONFIGURABLE CONVEYOR SYSTEM

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Robotics & Automation) (Hons.)

by

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TAJUK: **Development of a Concept for Physical Reconfigurable Conveyor System**

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APPROVAL

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 (Robotics and Automation) (Hons.). The member of the supervisory is as follow:

……

(Dr.-Ing. Azrul Azwan Bin Abdul Rahman)

ABSTRAK

Kebanyakan industri pembuatan menggunakan aplikasi pengendalian bahan pada masa sekarang. Penghantar adalah salah satu peralatan yang penting dalam pengendalian bahan. Penghantar dapat memindahkan sesuatu produk dari satu tempat ke tempat lain. Satu konsep tentang fizikal sistem penghantar pembentukan-semula telah dihasilkan untuk memenuhi permintaan pasaran dengan kos yang berpatutan dan menurunkan kos dan kerja penyelenggaraan. Konsep fizikal sistem penghantar pembentukan-semula telah dikaji dan reka bentuk konsep untuk sistem ini telah dimodelkan dan disahkan dengan menggunakan perisian reka bentuk. Perisian reka bentuk yang digunakan dalam projek ini adalah SolidWorks. Susun atur yang berbeza disusun dengan menggunakan komponen modular yang telah direka. Sebanyak lima keperluan telah dicadangkan dalam proses menghasilkan konsep system tersebut iaitu ketinggian boleh dilaraskan, kunci magnet laras, modulaliti, penukaran dan masa pertukaran susun atur yang pendek. Semua lukisan terperinci telah direka dan reka bentuk dianalisis dijalankan dengan menggunakan perisian Kejuruteraan Bantuan Komputer (CAE). Objektif projek tersebut telah tercapai.

ABSTRACT

Most of the manufacturing industries now deal with material handling applications. Conveyor is one of the most important material handling equipment which able to transfer the product from one place to another. A concept of the physical reconfigurable conveyor system is developed in order to meet the market responsiveness at a reasonable cost with less maintenance cost and work. The concept of physical reconfiguration of the conveyor system is studied and the design of the concept for the physical reconfigurable conveyor system is modeled and verified by using design software. The design software that used in this project is SolidWorks (solid modeling CAD software). Different layouts are arranged by using the designed modular components. There are five requirements of the reconfigurable conveyor system had been proposed which are adjustable height, adjustable magnet lock, modularity, convertibility and short layout changeover time. All the detail drawings of the reconfigurable conveyor system are generated and the design is analyzed by using Computer Aided Engineering (CAE) software. In future, the prototype of the concept for the reconfigurable conveyor system can be developed in order to get a realistic result.

DEDICATION

To my beloved parents, lecturers and friends whose have guided and inspired me through this education journey and also thanks to their fully support, belief and motivation.

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I would like to thank you for all who have helped in completing this report. A very special thanks to my kind and helpful supervisor Dr.-Ing. Azrul Azwan Bin Abdul Rahman for his guide and willingness to share his knowledge. Besides that, it would not have been possible without the kind and fully support from my beloved parents. Gratitude to all my friends for the support and sharing of knowledge and partially anticipated in this project. I would like to extend my sincere thanks to all of them.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AGV	-	Automated Guided Vehicle
CAD	-	Computer Aided Design
CAE	-	Computer Aided Engineering
FMHS	-	Flexible Material Handling System
FMS	-	Flexible Manufacturing System
DMS	-	Dedicated Manufacturing System
RMS	-	Reconfigurable Manufacturing System
MCE	-	Modular Conveyor Express
PSM	-	Projek Sarjana Muda
RMHS	-	Reconfigurable Material Handling System
vs	-	Versus
MOST	-	Maynard Operation Sequence Technique
TMU	-	Time Measurement Unit
min	-	Minutes

CHAPTER 1

INTRODUCTION

This chapter gives an overview about this project entitled ―Development of a Concept for Physical Reconfigurable Conveyor System". Problem statement, objectives, scopes and thesis structure will be discussed in the following section.

1.1 Background of study

Manufacturing industry plays an important role and made a large influence in the country's economic growth. However, the manufacturing industry needs to face unpredictable, high-frequency market changes, and other challenges due to globalization in this 21st century. These companies must possess new types of manufacturing systems in order to stay competitive to each other the new manufacturing system should be cost-effective and very responsive to all these market changes (Koren et al., 1999). A new conveyor system should be implements first instead of possess a new manufacturing system. This is due to conveyor is a composed of material handling system which occurred in most of the manufacturing system. A conveyor system is a common type of mechanical handling equipment which transfers and moves materials from one place to another (Dematic, 2014).

Reconfigurability, the ability to change and rearrange the behaviors of a system by only changing its configuration in a cost-effective way (Setchi et al., 2004). This new engineering technology able to react and change. Reconfigurable conveyor system has the ability to arrange n rearrange a wide variety of module with different layout by the engineer without any additional cost for purchase a brand new conveyor and losing the conveyor's behaviors. It can be reconfigured over and over again (Jill Batka, 2011). Timm Ducey (2011) states that a truly reconfigurable conveyors are likes LEGOs which provide ultimate reconfigurability. We cannot mess up the reconfigurable systems actually. The changes of a reconfigurable conveyor can be made simply by just swapping out the modules with the release of a few bolts and nuts and snapping the modules in or out (Jill Batka, 2011). A reconfigurable conveyor system is comprised from the combination of physical and logical configuration. Physical conveyor unit is the hardware of the conveyor such as conveyor components, conveyor types, and system design layout whereas logical conveyor unit is the controller which control the movement of the transport item through the conveyor system (Wentzel et al., 2012).

1.2 Problem Statement

The current manufacturing systems are mainly dominated by Dedicated Manufacturing system (DMS) and Flexible manufacturing system (FMS). Due to some problems occurred in this manufacturing system such as dynamic nature and complexities in the mining manufacturing environment in terms of space available, kind of mining operations and the risks involved, unable to meet the market responsiveness requirements at a reasonable costs and longer changeover time, some improvements or new system is needed in order to meet customer's requirements. A new type of manufacturing systems which are cost-effective and very responsive to all these market changes needed in order to stay competitive with other industry. Reconfigurable conveyor system offers significant flexibility, making efficient use of available space (An et al., 2011) able to reconfigured over and over again and low

maintenance costs. A concept for this reconfigurable conveyor system need to be developed.

1.3 Objectives

- To develop a concept of physical reconfigurable conveyor system.
- To model and verify a reconfigurable conveyor system concept by using experimental or Computer Aided Engineering (CAE) software.

1.4 Scopes

The scopes of this project are :

a) To study and understand the concept of reconfigurable conveyor system especially in the concept of physical reconfiguration.
b) Focus on the study and understanding of belt conveyor.
c) The design of the concept for the physical reconfigurable conveyor system is going to be model and verify by using design and CAD software.
d) The proposed specifications of the layout changeover time is going to analyse by using predetermined time system method – MOST analysis method.

1.5 Thesis Structure

This PSM report consists of five chapters that will explain details about this project. Table 1.1 shows the activities of the project for five chapters. The first chapter of this report is about the introduction of the project which includes background of study,

problem statement, objectives, and scopes. It is then followed by Chapter 2 which provided a literature review on the prior researchers on the reconfigurable conveyor system, material handling approaches, type of existing conveyors and conveyor system layout. Next, Chapter 3 is the methodology that covered the descriptions and procedures while doing the project including methods applied system, software and flow charts of the project. In Chapter 4, the result and discussion of the project is covered. The detailed design drawing, design study and analysis and layout changeover time analysis will be discussed. The last chapter which is Chapter 5 will covered the conclusion and future improvement of the project.

Table 1.1: Activities of the project for five chapters.

Chapter	Activity
1. Introduction	• Background of Study, Problem Statement, Objectives, Scopes.
2. Literature Review	• Material Handling (conveyor components, types of conveyor, conveyor system layout and life cycle of conveyor system.) • Reconfigurability (flexibility vs reconfigurability and physical configuration vs logical configuration) • Reconfigurable Conveyor System (characteristic – modularity, customization and convertibility) • State of Art of RMHS (current state of commercial and research)
3. Methodology	• Project Implementation (flow chart) • Tools Used (SolidWorks – design drawing and animation) • Proposed Specifications for Reconfigurable Conveyor (turntable, adjustable height, short changeover time)
4. Result and Discussion	• Detailed Drawing (Adjustable Steel Combine Stand, Adjuster Wheel, Adjustable Magnetic Lock and Modules of the reconfigurable conveyor system) • Design Study and Analysis (Procedure to create module layout and Possible module layout arrangements) • Layout Changeover Time Analysis (MOST Analysis Method)
5. Conclusion and Recommendation	• Conclusion and future improvement

CHAPTER 2

LITERATURE REVIEW

The literature review undertaken as a part of development of a concept of physical reconfigurable conveyor system project. This project was focused on material handling especially conveyor, system reconfigurability, characteristic of reconfigurable conveyor system and current state of the art reconfigurable material handling system (RMHS).

2.1 Material Handling

Material handling refers to the movement, storage, protection and control of products and materials throughout the processes of manufacturing, disposal, distribution and consumption of all related materials and goods (Kardex Remstar, 2014). Material handling industry manufactures and distributes the equipment and system required to implement the material handling systems. The material handling process will incorporates a wide variety of either manual, semi-automated or fully automated equipment and systems that support import and export of materials and make the supply chain work (MHI, 2014).

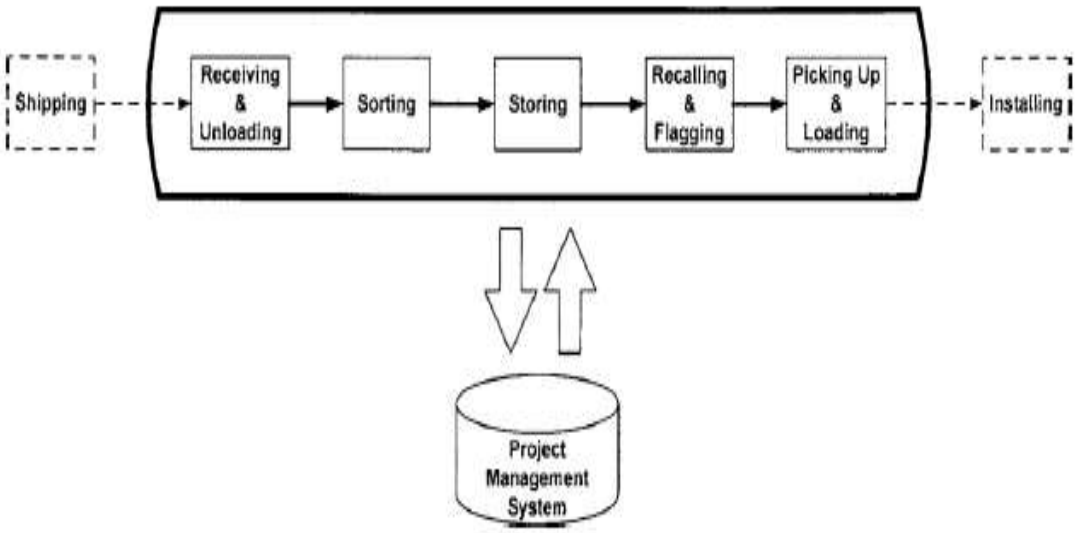

Figure 2.1: A simple example of material handling system.

2.1.1. Material Handling Equipment – Conveyor

Material handling equipment normally is used for the storage and movement of material within a facility or manufacturing industry. Material handling equipment can be classified into five major categories which are transport equipment, positioning equipment, unit load formation equipment, storage equipment and identification and control equipment (MHE Taxonomy, 1999). The availability of manual, semi-automated and fully automated material handling equipment and technologies able to support the material handling equipment which include conveyors, industrial robot, Automated Guided Vehicle (AGVs) and others (MHI, 2014).

We will focus and discuss more on conveyor equipment since the objective of this project is to develop a concept of physical reconfigurable conveyor system. Conveyors are another form of material handling. They used to move materials,

products or goods throughout a manufacturing or distribution facility. Conveyors can be horizontal, inclined or vertical which are powered by hydraulic or pneumatic or electric power. Conveyors are especially useful in applications which involve in the transportation of heavy or bulky materials. Conveyors have the ability to reduce labor costs by eliminating non-value-added travel time because they enable large quantity of materials to be moved rapidly through a process or facility (MHI, 2014). Conveyors consist of several types with different system layout.

2.1.2 Conveyor Components

2.1.2.1 Conveyor Belt

Belt is an important component for a conveyor system which made up of one or more layer of rubber. Belt normally combined with two or more pulleys with continuous and closed loop as carry medium. The belt will move and the material on the belt will move forward also when one or both of the pulleys are powered. The powered pulley is called the drive pulley where the unpowered pulley is called the idler pulley.

Figure 2.2: Belt and Pulleys