



UNIVERSITI TEKNIKAL MALAYSIA, MELAKA

Development of a Semi-Automated Material Handling System for Laser Cutting Machine

Thesis submitted in accordance with the requirements of the Universiti Teknikal Malaysia, Melaka for the Bachelor Degree of Manufacturing Engineering in Robotic and Automation

By

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May 2008



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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APPROVAL

This PSM submitted to the senate of UTeM and has been as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotic & Automation). The members of the supervisory committee are as follow:

.....

(Mr. Hassan Attan)

Date: _____

ABSTRACT

Nowadays, material handling system application is wide ranging in world-class shipyards, spanning design and manufacturing sector. Among the usage of material handling is to provide transportation and storage for materials, components and assemblies. In this project, a semi automated material handling system is design for the laser cutting machine to enhance the overall performance of the laser cutting machine and also reducing the human work for material handling task. As a starting point for this project, research (from internet sources, journals and books) is done to compare the types of material handling system that are available. By the same time, analysis is done to make sure that the most effective semi automated material handling system is designed for this project. Either than that, a study on computer program or design and analysis software is done to make the designing works easier. Parametric design software is used to sketch and assembly the overall design for the semi automated material handling system to the existing laser cutting machine to make sure that the design is fit to each others.

Later, components selection and communicate with supplier around the world is very important in order to carry out a prototype of the semi automated handling system.

ABSTRAK

Pada masa kini, kilang pembuatan kapal, bidang reka bentuk dan bidang pembuatan menggunakan aplikasi sistem pengangkutan bahan secara meluas. Di antara kegunaan sistem pengangkutan bahan adalah untuk tujuan pengangkutan dan simpanan untuk bahan, komponen dan cantuman komponen. Projek ini merekabentuk satu sistem pengangkutan bahan separuh automatik untuk mesin pemotongan laser. Tujuan memperkenalkan sistem ini adalah untuk mesin pemotongan laser meningkatkan prestasi mesin dan juga untuk mengurangkan penglibatan manusia dalam kerja pengangkutan bahan. Projek ini dimulakan dengan membuat kajian terhadap sumber-sumber yang berkaitan dari internet, jurnal dan buku. Selain itu, analisis dijalankan untuk memastikan sistem pengangkutan bahan yang paling efektif dipilih untuk projek ini. Di samping itu, pembelajaran dalam program rekabentuk seperti SolidWorks digunakan untuk memudahkan kerja rekabentuk. Program tersebut akan digunakan untuk melukis secara logik rekabentuk bagi sistem pengangkutan bahan separuh automatik itu. Ia juga digunakan untuk memastikan sistem pengangkutan bahan yang direka adalah sesuai digunakan dengan mesin pemotongan laser tersebut.

Selepas itu, pemilihan komponen-komponen yang berkaitan dijalankan dengan bantuan pembekal-pembekal dari Malaysia dan luar Negara.

DEDICATION

I dedicate this work:

To my caring father,

Mr. Ng Sing Eng

To my lovely mother,

Mrs. Tan Lee Yeng

To my beloved brothers and sisters

To my supervisor,

Mr. Hassan Attan

And the other person those are my constant sources of encouragement.....

ACKNOWLEDGEMENTS

First of all, I would like to thank to God because under His blessing and willingness, I was able to complete the tasks and report for my PSM entitled 'Development of a semi automated material handling system for a laser cutting machine'. Besides that, a special thanks to Dean of Manufacturing Engineering Faculty, Prof Dr Razali Muhammad which provides facilities inside the campus that makes my jobs easier in this project.

I would like to express my sincere grateful and appreciation to my supervisor, Encik Hassan Attan for his willingness to accept me as his student and also sacrifices a lot of his precious time to support, sharing ideas and experience with me. I believe that, this report would not been completed properly without the guidance from my supervisor. Besides that, I also want to dedicate the big thankful to the FKP staff including the academic staff, management staff, and lab technicians for their help hands during the completion of this report.

Also, a special thanks to my beloved family for their support and encouragement that made me feel that the completion of this project is a possible task. I would like to thank to all my friends from UTeM and my hometown for always giving their support and encouragement when I am facing difficulties to complete this project.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

UTeM	-	Universiti Teknikal Malaysia Melaka
CAD	-	Computer-aided design
CNC	-	Computer numerical control
BLS	-	Bureau of Labor Statistics
MH	-	Material Handling
MHS	-	Material Handling system
3-D	-	3-dimensional
AGVs	-	Automated Guided Vehicles
PSM	-	Project Sarjana Muda
Kg	-	kilogram
Mm	-	millimeter
lb.	-	pounds
ft.	-	feet

CHAPTER 1

INTRODUCTION

1.1 Introduction

Most people think of technology in terms of its artifacts like aircraft, pesticides, water-treatment plants, birth-control pills, and microwave ovens, computers and software. However, technology is more than these products that have been mentioned. As mentioned in National Academy of Engineering's official website, technology does includes the entire infrastructure necessary for the design, manufacture, operation, and repair of technological artifacts, from corporate headquarters and engineering schools to manufacturing plants and maintenance facilities. The knowledge and processes used to create and to operate technological are equally important part of technology. [1] According to International Technology Education Association (ITEA), technology is defined as

- a. Human innovation in action that involves the generation of knowledge and processes to develop systems that solve problems and extend human capabilities. [2]
- b. The innovation, change, or modification of the natural environment to satisfy perceived human needs and wants. [2]

Technology is an important terms in human life. It can be seen from the wide applications of technology surrounding us nowadays. Technology has been applied in sectors like manufacturing, food, telecommunication, agriculture and many more. In manufacturing sector, there are many development that have been done that lead the country to become one of the best develop country in the world. The development of technology in manufacturing sector has made human life more flexible, easier, faster and simple. The development of technology that

mentioned means the usage of automated or semi automated system used to replace the job than usually been done manually by human.

One of the applications of technology is in the laser cutting machine. Laser cutting machine is a machine which uses laser as a cutting medium. From EFUNDA engineering fundamentals official website, laser cutting is defined as a process by which complex outlines can be cut in sheet metal and in an accurate manner. Laser cutting takes direct input in the form of electronic data from a CAD drawing to produce flat form parts of great complexity. The material then either melts burns or vaporizes away leaving an edge with a high quality surface finish. [3]

As we study before this, laser cutting is a very high level type of technology in manufacturing sector. However, a laser cutting machine that has a high technology in term of laser cutting does not mean it's applying high technology in terms or material handling. Most of the industries are still using manual material handling system that is not effective in term of production and safety.

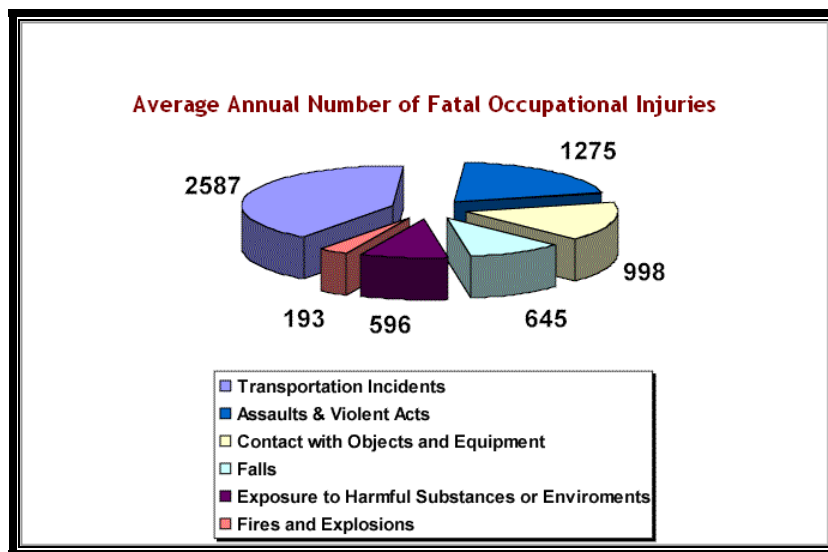


Figure 1.1: Average annual number of fatal occupational injuries [4]

Figure 1.1 shows that number of occupational injuries that occurs with reference from Bureau of Labor Statistics (BLS) by event or exposure between 1992 and 1997.[4] As we can see, there are

998 cases out of 6294 cases is caused when workers are having contact with objects and equipment. This statistics proved that the material handling system is not effective to prevent injuries to workers. Hence, a better technology should be applied in material handling system to increase the safety factor and also the effectiveness of production. For this project, an automated or semi automated material handling system for a laser cutting machine should be carry out for the outcome of this project.

1.2 Background of Study

The knowledge that needs to be used when dealing with this project is includes manufacturing design and automation system. The field of work includes CAD designing and research about the types of material handling system that are currently using in manufacturing sector especially for laser cutting machine.

1.3 Problem statement

Laser cutting is one of the most advance cutting methods to cut the 2D profiles in UTeM. Anyway, the material handling system in the lab is using the traditional handling system which is manual handling machine operators. Manual handling system is cheap in term of cost, harmful in term of safety and time consuming. The problems of current handling system are:

- a. The chance of injury to workers might happen when workers is handling the material manually.
- b. Manual lifting will involved at least two people to lift the sheet metal. The dimension of the plate used is 2438 mm (8 feet) length and 1219 mm (4 feet) width. The estimation weight of the plate range from 22 kg (49lb) to 68 kg (148lb.). By considering the weight and size of the plate, it will always be harmful for anyone that needs to lift the material onto the laser cutting machine.

- c. When moving large sheet metal from the storage to the laser cutting machine, there are a lot of space needed.

1.4 Objectives of the project

The objectives of this project are as follow:

- a. To design a universal semi automated material handling system for a laser cutting machine.
- b. To increase the productivity of the laser cutting process.
- c. To enhance the safety factor when operating a laser cutting machine.
- d. To reduce material damage during material handling.

1.5 SCOPE

The scope of this project includes:

- a. Design a semi-automated material handling system for laser cutting machine.
- b. Include the use of pneumatic components to perform as a semi-automated material handling system.
- c. Identified the weight of material to be supported by the material handling system.
- d. Study the existing material handling system within the laser cutting industries.

1.6 Research background

First of all, the research for this project is done in the Fabrication workshop at University Teknikal Malaysia Melaka (UTeM). In the workshop, there is a laser cutting machine that operates without automated material handling system. The only material handling system that is use with the machine is by manual lifting by operator of the machine and lift truck. By considering several factors such as safety and ease of maintenance, a research about ways to

apply a semi-automated material handling system to the laser cutting in the workshop is undergoing.

1.7 Terminology

During the completion of the project, there are terms that will be frequently used in order to explain some of the related process. Among the terms that mentioned are materials handling system and laser cutting machine.

1.7.1 Material Handling system

Generally, materials handling systems provide transportation and storage of materials, components and assemblies. Material handling activities start with unloading of goods from delivery transportation, goods is then pass into storage, onto machining, assembly, testing, storage, packaging, storage, and finally loading onto transport.[5] Each of these stages of the production process requires a slightly different design of handling equipment, and some processes require integration of multiple items of handling equipment. Therefore, the development of a material handling system is one of the most important developments in manufacturing sectors.

1.7.2 Laser Cutting machine

Laser cutting machine is a type of machine that used a laser to cut materials. Laser cutting works by directing the output of a high power laser by controlled laser used movement using CNC, at the material to be cut. The material then either melts burns or vaporizes away leaving an edge with a high quality surface finish. Industrial laser cutters are used to cut flat-sheet material as well as structural and piping materials. Some 6-axis lasers can perform cutting operations on parts that have been pre-formed by casting or machining. [6]

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Design or selection of the right material handling system is one of the most important decisions that a designer can make, because of the effects on the rest of the manufacturing plant. It affects the material flow and the factory layout. Apart from the initial capital cost for a new system, the consequences of any misjudgment in material handling will have considerable and long-term effects on operations. In recent years computer based simulation tools have been developed to simulate material handling systems and their effect on the manufacturing process.

Material handling (MH) accounts for 30–75% of the total cost of a product, and efficient material handling can be responsible for reducing the manufacturing system operations cost by 15–30%. [7] These figures underscore the importance of material handling costs as an element in improving the cost structure of a product. The determination of a material handling system involves both the selection of suitable material handling equipment and the assignment of material handling operations to each individual piece of equipment. Hence, material handling system selection can be defined as the selection of material handling equipment to perform material handling operations within a working area considering all aspects of the products to be handled. The material handling system (MHS) plays a crucial role in industries. When improperly designed, the MHS indeed can interfere severely with the overall performance of the system and lead to substantial losses in productivity and competitiveness, and to unacceptably long lead times. Thus, to avoid such pitfalls, MHS design must be integrated into the overall design of the manufacturing system which centers on the selection of machines and the allocation of operations to the machines. Commonly material handling system is divided into three categories

which are manual handling system, semi-automated handling system and automated handling system.

2.2 Type of material handling system

2.2.1 Manual handling system

The most traditional ways used for material handling is manual handling system. It is said to be traditional because of its usage period is the longest among all type of material handling system. Manual handling system is totally using the human energy as a lifting device to transfer a material from a location to another location. The laser cutting machine in FKP fabrication lab is using this kind of handling system. It requires the operator of the machine to lift the material onto the laser cutting machine for cutting processes. There are several advantages using the manual handling system that can be mention are as follows.

a. Lower cost

Manual material handling system uses human energy as handling device. Hence, it does not require any kind of mechanical transfer devices that are expensive.

b. Flexible operating procedure

This type of material handling system is flexible because its position does not fix. It does not influence by any changes of machine layout or the added of new machine.

c. Ease of maintenance

This traditional handling system is free from complicated programming code or wiring circuit. In additional, phenomena like machine breakdown also prevented since there are no specific mechanical device used.

Although the usage of this kind of material handling system is last for a long period, but there are still disadvantages behind of its advantages. Among the disadvantages are: