UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF MACHINING WASTE COLLECTION SYSTEM TO ENHANCE SAFETY AND PRODUCTIVITY

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering Technology (Product Design) with Honours

by

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Signature	:	…….
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APPROVAL

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

…….

(MR. MOHD RAZALI BIN MD YUNOS)

(Project Supervisor)

ABSTRAK

Machining Waste Collection System adalah sebuah prototaip yang diubahsuai daripada *Chip Compactor*. Tujuan prototaip ini dibangunkan adalah untuk menghasilkan sebuah prototaip yang mempunyai fungsi pemadatan dan sistem pengasingan yang sangat berguna kepada operator di industri pemesinan logam dan pemesinan bengkel di institusi pendidikan. Pelaksanaan projek ini melibatkan beberapa kaedah. Bermula dengan perancangan projek, pencarian maklumat dan diteruskan dengan pembangunan prototaip, segalanya diuruskan dengan baik sehingga peringkat pengujian untuk menentukan keberkesanan fungsi prototaip. Rujukan mengenai kajian-kajian terdahulu banyak membantu dalam memahami sifat-sifat dan konsep *Machining Waste Collection System* serta aplikasinya. Di samping itu, untuk mendapat hasil yang baik, pelbagai maklumat tentang pemadat juga dikumpul daripada sumber-sumber seperti buku-buku, artikel dan jurnal sebagai garis panduan yang baik. Selain itu, kemahiran merekabentuk prototaip dibantu oleh pengetahuan tambahan dalam menilai dan memilih konsep rekabentuk yang terbaik juga diadaptasikan. Melalui maklumat penyelidikan, idea konsep reka bentuk disumbangkan daripada produk sedia ada yang terdapat di industri dan pasaran. Beberapa idea baru juga telah dihasilkan oleh contoh yang baik daripada produk sedia ada yang digunakan. Kemudian, untuk memanfaatkan idea dan maklumat yang ada, ia hanya dapat dilihat dengan kelancaran proses pembangunan dan hasil prototaip *Machining Waste Collection System* yang sebenar pada akhir pelaksanaa projek. *Machining Waste Collection System* mempunyai ciri-ciri pemadatan yang dikawal mengunakan roda tangan. Ciri-ciri tambahan lain adalah sistem pengasingan dan reka bentuk yang lebih menarik daripada struktur utama. Struktur utama prototaip juga direka supaya lebih selamat dan selesa digunakan.

ABSTRACT

Machining waste collection system is a modification prototype from the current used of chip compactor .The purpose of this prototype is to develop a functional prototype that have compacting function and separation system which is very useful to the operator at the metal machining industry or machining workshop in educational institutes. To implement the development of this prototype, it involves some of methodology flow. Started with project planning, information searching and then further with prototype development, there was been manage well until the testing that determine the functional of machining waste collection system prototype. By done a lot of revision and study about the previous researches, its help more to understand the concept and its application for use in this prototype. In addition, to have a good result of this project, the information about compactor is also gathered from the published books, articles and journals as good guidelines. Besides getting sharp of design skill, the extra gaining of knowledge in evaluates and select the best design concept are really valuable. Through the research information, the idea of design concept is contributed from the current product that available in the industry and purchasing marketplace. Some new idea also had been generated by the good example of the current used products. Then to make all the things of information useful, it already performed in real outcome of machining waste collection system prototype at the end of the project implementation period. Machining waste collection systems apply the compaction mechanism that is controlled by farm jack mechanism. The other extra features are separation system and the more attractive design of the main structure. All the path of prototype development phases is explained clearly in the methodology stages and the result discussion is completed in the next chapter.

DEDICATION

To my lovely mum and dad,

Hamidah binti Md Noor and Zulkafli Bin Omar,

With loving sacrifices and their unconditionally support in my life.

To my sibling and my friends,

Who always helped me prepared and completed this report.

And

For those I love very much

For the lecturers, my supervisors, assistant engineers who are given much guidance to me without expecting any reward.

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Praise to Allah, The Lord of the Worlds. With His blessing and guidance, I have completed this Final Year Project successful even though along the way there are many hardship and obstacles. I would like to thank my supervisor, Mr. Mohd Razali Bin Md Yunos and my co supervisor Mr. Abdul Khahar Bin Nordin for guiding and supporting me throughout the project. And also special thanks to both of them because spending their precious time for giving me ideas throughout this project. Not to forget to thank all assistant engineer especially Mr. Basri bin Bidin who give me a lot of assistance and information and also help me a lot to complete this project. Last but not least, I would like to thank everyone that involved directly and indirectly in this project.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

CNC	-	Computer Numerical Control
3D	-	3 Dimensional
FTK	-	Fakulti Teknologi Kejuruteraan
UTeM	-	Universiti Teknikal Malaysia Melaka
Hp	-	Horsepower
Lbs	-	ibra balance or scales
W	-	Width
D	-	Depth
H	-	Height
EPA	-	Environmental Protection Agency
FYP	-	Final Year Project
CAD	-	Computer Aided Design
PSM	-	Projek Sarjana Muda
MIG	-	Metal Inert Gas
SMAW	-	Shielded Metal Arc Welding

CHAPTER 1

INTRODUCTION

1.0 Introduction

Conventional or CNC machining is a subtractive process, meaning that the process starts with more material than the product needs and cuts away, or "subtracts," any excess material. The material removed from the finished part end up becoming waste or chip. The most common machining processes which produce chips are turning, milling and drilling operation. Metal chips or machining waste of metal actually remove pieces of metal that is not used or involved in final product. The aspects of small, tiny and sharpie, the metal chips produced makes working environment not safe.

Safe Working Environment cannot be "built- in" to a workplace that factor can only be supplied by a responsible operator! – *(Safe Work Australia, 2009)*

The sentence above is trying to advice all the people in the related field of engineering to be concern about safety. Even with the good condition of machinery in the production line during machining process, it is hard to expose the workers to the extremely dangerous if the environment is not secured. Metal machining generates large amounts of extremely hot metal machining waste as they come off the tool bit and the work piece.

The chip remains a safety concern even after cooling due to their sharpness and accumulation in the immediate work area. Machining waste can cause severe cuts for the worker fingers while being cleared from operating machines and long chips can "drag" over and around the machine, posing a serious safety concern. The

workers been reminded never to remove accumulated or moving chips from a machine as well as scattered chips on the floor with their fingers.

Machining waste on the floor of the working area can cut into short or server electric cords even the worker's body also. Sharp chips can completely cut hoses or lines if stepped on, or if machinery is rolled over them. By only having brooms and waste containers handy separately by material and manage cutting fragment in the work area. This machine is to make the volume of the chips as small as possible in order to have a compact, high density and specific fashion of 3D shape for the purpose of reducing of transportation cost, as well as to gain the more value for chips with same weight. The project is carried out the compactor machine is designed keeping in the size as compact as possible and ease of availability of materials required to build it. Then the machine is constructed with mild steel sheet metal and other hardened metal objects.

1.1 Problem Statement

The usage of CNC and conventional machine in training institutions and universities become widely used due to its sophisticated technology. The machining waste will produced by the CNC machines because of the various processes such as drilling, cutting, knurling and etc. According to M. Torkar (2010), wastes that were traditionally discarded from industry production are nowadays recycled. The discarding of waste material has a negative environmental impact. Therefore, the main problem to focus in this project is discarded coolants from the manufacturing of metal have a more harmful impact on the environment than dry chip processing. This means that the coolants have to be removed in order to obtain more environmental friendly waste from the chips generated before it being re-melt for recycle. However, some of the machining waste is made up of metal or non-metal chip which are high specific volume and low density that makes more difficult to re-melt.

In addition, the transportation of uncompact chips is very costly due it is occupy large spaces. Therefore, the higher size of non-compaction machining waste will affected the cost and capacity during transportation.

1.2 Objectives

The ultimate objective of this project is to enhance safety and productivity. This objective can be achieves with following specific goals:

i. To design a machining waste collection system.
ii. To fabricate the prototype that can separate the oil and coolant from the chip and compact the machining waste.
iii. To analyse the performance of the machine in term of ergonomic, dryness of the chips, user-friendly and percentages of size reduction.

1.3 Project Scope

The major scope of this project is to focus on machining waste of CNC and Conventional machine at FTK Laboratory only. Besides, machining waste is specifically for metal chip. On this project, it is limited to develop compacting and separation system only. Furthermore, the design work will include the application of modelling software to show clearly about the development. The design of the machine is designed using Solid Work software before analyse the machining waste collection system performance in terms of environment, ergonomic, dryness of the chip. Manufacturing process will included in order to fabricate the machine.

1.4 Result Expectation

i. The compactor will have ergonomic impact to the user.
ii. The percentage of size reduction reduces by 40-60 %.
iii. A dry compacted machining waste (chip) produced by the compactor so it can be re-melt easily.
iv. Compacted chip can create something new that can save raw material and cost of transportation.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This is the body section of the entire text that aims to review the critical points of current knowledge on the topic of project. It is used to form the justification for the future research in the area. A literature review consists of current and relevant references with consistent.

2.1 Workshop Safety, Health, and Environment Concern.

Successful health and safety management in small engineering workshops is about identifying the most frequent and serious risks and adopting the right precautions, taking account of time, money and resources. Most accidents at all types of machine, including conventional and CNC machines, happen to operators during normal operation when loading or unloading components, removing swarf and taking measurements and making adjustments (to the coolant supply in particular).

On manually operated machines, the most dangerous machine movements are the rotating, cutting, shearing, sawing or pressing movements of tools, particularly on presses, drilling machines, milling machines, lathes, metal cutting saws, guillotines and grinding machines. Hands are most frequently injured, the most numerous injuries being cuts and abrasions, many of which are severe. Broken bones and dislocations are numerous. Amputations of fingers and hands are not infrequent and

there are some fatalities, often arising from entanglements, every year. Eye injuries are also common.

Safety measure to prevent access to dangerous movements during batch production at manually operated machines use fixed guards with jigs and fixtures (such as sliding trays) to load and unload components away from the tools. Safe means of removing swarf (such as a hook or rake which may be inserted through small openings in fixed guards) and adjusting coolant (such as taps outside fixed guards). (Health and Safety Executive, 2014)

2.2 Industrial Waste

According to Australian industry group (2016), metal manufacturers generate waste through activity such as machining .The major environmental wastes in this sector involve the use and disposal of machine lubricants and coolants, aqueous and solvent cleaning systems and recycling of scrap. Hazardous wastes, such as solvents, pickling solutions and oils, can be expensive to manage as they require special waste treatment and disposal arrangements.

2.3 Metal Machining Processes

Metal machining process can be described as removal of the material from a workpiece, it covers several processes, which we usually divide into the following categories:

- Cutting, generally involving single-point or multipoint cutting tools, each with a clearly defined geometry.
- Abrasive processes, such as grinding.
- Non-traditional machining processes, utilization electrical, chemical, and optimal sources of energy.

It is important to view machining processes as well as all manufacturing operations, as a system which consisting of the work piece, the tool and the machine. The traditional machine includes primers on turning, milling, drilling and grinding. Years to years the machining processes have been applied in the manufacturing industry, until now it is become more easily and advanced because of computer applications. The primers machining processes have good integration with the technology of computer that makes it more intelligent and friendly with the users. (Michigan Technological University, 2007)

2.3.1 Material Removal Processes

According to George. S (2002), in machining process, material will removed from surface of the workpiece by producing chips. If the type of material of the workpiece is metal the chips formation is metal chips.as stated earlier, the processes involved in the metal removing process are cutting, milling, turning, grinding ,drilling and threading. In turning operation the workpiece is rotated and a cutting tool removes a layer of material as it move particular to the workpiece, and the cutting tool moves radially inward and separates the right piece of the workpiece. For milling operation, a rotating cutter travels along a certain depth in the workpiece and produces gravity by removing the material out. This is a bit different in grinding process, which removes material by not using specific shape of cutting tools. The cutter is smaller, non-metallic hard particle that having sharp edges and irregular shape called abrasive. These are the way metals chips produced from the machining operation.

2.3.2 Metal Chips Formation

As known before, chips are formed during the machining of work pieces. The side of the chip in contact with the cutting tool is normally shiny, flat and smooth while the other side, which is the free workpiece surface, is

jagged due to shear. For more detail information about how the metal chip removed from the material, first is to know how the deformation of a work material occurred. It means that enough force has been exerted by the tool to permanently reshape or fracture the work material. If the material is reshaped, it is said to have exceeded its plastic limit. A chip is a combination of reshaping and fracturing. The deformed chip is separated from the parent material by fracture. The cutting action and the chip formation can be more easily analysed if the edge of the tool is set perpendicular to the relative motion of the material, as shown in figure2.1 below. From the figure 2.1, the label of the un-deformed chip thickness, t_1 is the value of the depth of cut, while t_2 is the thickness of the deformed chip after leaving the workpiece. The major deformation starts at the shear zone and diameter determines the angle of shear. (George,S. 2002).

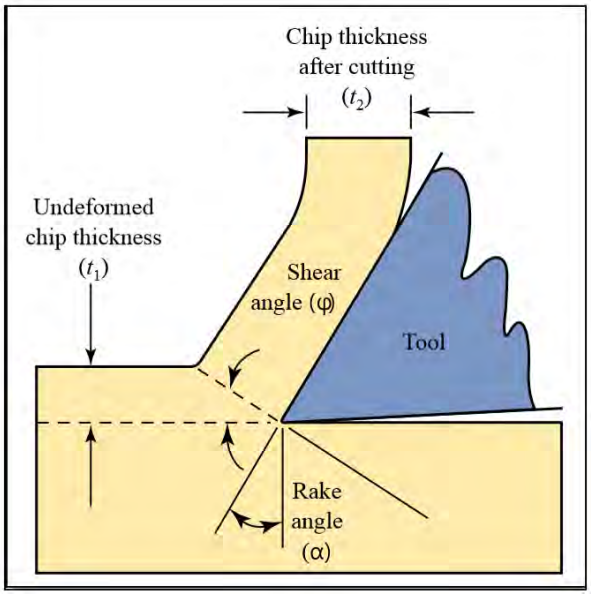

Figure 2.1: Chip Formation showing the deformation of the material being machine. (George ,S. 2002).

A general discussion of the forces acting in metal cutting is presented by using the example of a typical turning operation. When a solid bar is turned, there are three forces acting on the cutting tool as shown in the figure below:

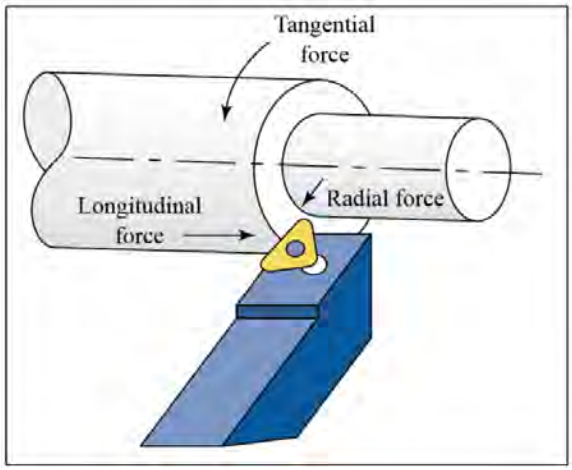

Figure 2.2: Forces acting on the cutting tools. (George Schneider, 2002).

a. Tangential forces: This acts in a direction tangential to the evolving workpiece and represents the resistance to the rotation of the workpiece. In a normal operation, tangential forces are the highest of the three forces and account for about 98 percent of the total power required by the operation.

b. Longitudinal forces: longitudinal force acts in the direction parallel to the axis of the work and represent to the longitudinal feed of the tool. Longitudinal force usually about 50 percent as great as tangential forces. Since feed velocity is usually very low in relation to the velocity of the rotating workpiece, longitudinal force account for only about 1 percent of total power required.

c. Radial force: Radial force acts in a radial direction from the centre line of the workpiece. The radial force is generally the smallest of the three, often about 50 percent as large as longitudinal force. Its effect on power requirements is very small because velocity in the radial direction is negligible. (George, S .2002)

2.4 Type of Metal Chips

Chips formation is part of machining process. It is form during cut the work piece by some of mechanical means. The chips depend on the material of work piece and tool and cutting condition. There are mainly three chips types. (George, S. 2002)

2.4.1 Discontinuous Chip formation

Discontinuous or segmented chips are produced when brittle metal such as cast iron and hard bronze are cut or when some ductile metals are cut under poor cutting conditions. As the point of the cutting tool contacts the metal, some compression occurs, and the chip begins flowing along the chip-tool interface. As more stress is applied to brittle metal by the cutting action, the metal compresses until it reaches a point where rupture occurs and the chip separates from the unmachined portion. This cycle is repeated indefinitely during the cutting operation, with the rupture of each segment occurring on the shear angle or plane. Generally, as a result of these successive ruptures, a poor surface is produced on the workpiece.

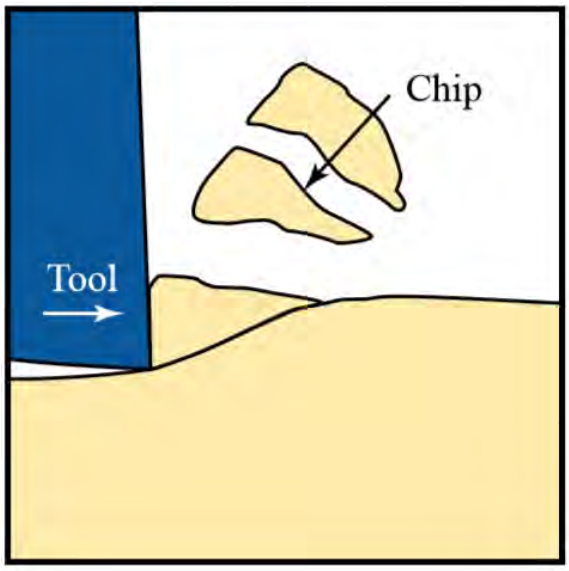

Figure 2.3: Formation of Discontinuous chip (George, S.2001)