

A PRELIMINARY DESIGN OF DURIAN PEELER: AN ERGONOMICS APPROACH

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion, this project is adequate in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering

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STUDENT'S DECLARATION

I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. The project has not been accepted for any degree and is not concurrently submitted for award of other degree.

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Dedicated to my beloved family

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ABSTRACT

This study is to design a durian peeler machine that followed the ergonomic criteria. The problem statement for this study is peeling durian can lead to MSD problem. Based on the problem statement, the objective of this study is to design a durian peeler with an ergonomics approach using Solidworks software. For the methodology, the design will be based on two sources of data which are data gathered from the literature review and data gathered from the survey conducted. Survey is conducted for those people that has an experienced in handling hand held tools. The data obtain from the survey will be used as a guideline to modified the previous designed which is based on literature review. For the result, a final design of durian peeler which is based on the literature review and the survey conducted would be drafted in Solidworks software. The justification for the designed is made to ensure the design achieve its objective. For the conclusion, theoretically the designed can be considered as ergonomics product.

ABSTRAK

Kajian ini adalah mengenai mereka bentuk sebuah mesin pengopek durian yang memenuhi ciri-ciri ergonomik. Permasalahan yang timbul untuk kajian ini adalah, kaedah mengopek durian secara manual meningkatkan potensi “MSD”. Berdasarkan daripada permasalahan yang dibangkitkan, objektif kajian ini telah ditetapkan iaitu mereka bentuk sebuah mesin pengopek durian yang memenuhi ciri-ciri ergonomik. Kaedah yang digunakan dalam kajian ini adalah dengan mereka bentuk mesin berdasarkan dua sumber data iaitu data dikumpul dari hasil pembacaan mengenai ergonomik dan juga data yang diperoleh daripada hasil soal selidik yang dibuat. Soal selidik yang dibuat diberi kepada pekerja yang mempunyai pengalaman menggunakan peralatan tangan. Data yang diperoleh akan digunakan sebagai panduan untuk memodifikasi mesin yang direka berdasarkan hasil pembacaan mengenai ergonomik. Hasil daripada kajian ini adalah, sebuah mesin pengopek durian yang bercirikan ergonomik telah dilukis di dalam perisian Solidworks. Justifikasi bagi mesin telah dibuat bagi memastikan mesin mencapai objektif kajian ini. Kesimpulannya, secara teori, mesin ini adalah sebuah mesin yang memenuhi ciri-ciri ergonomik.

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LIST OF ABBREVIATIONS

MSD	Musculoskeletal disorders
SME	Small and medium enterprise
MARDI	Malaysian Agricultural Research and Development Institute

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Malaysia is a country that is rich with natural resources in areas such as agriculture. For example, Malaysia is one of the top exporters of palm oil and natural rubber, together with tobacco, sawn logs and sawn timber, pineapple and paper dominate the growth of the sector. Besides that, Malaysia is also well-known for its fruits taste. There are plenty of delicious fruit can be found in Malaysia such as durian, rambutan, mango, mangosteen, watermelon, papaya, and many more

Durian is the fruit of several trees species belongs to genus *Durio* and the *malvaceae* families which is edible by human being, (Missouri Botanical Garden). Durian can grow as long as 30 centimeters and 15 centimeters in diameter and weigh around 1 to 3 kilograms (Brown and Michael J, 1997).Physically, durian fruit is armed with sharp thorn that have high possibility to cause injury to human being. For durian tree, it can grow up to 25 meters to 50 meters depending on the species. Durian leaves are evergreen, elliptic to oblong and 10 centimeters to 18 centimeters long.

Peeling durian is not an easy process. There are several problems that need to be encountered during peeling durian process. First problem is durian has a parabolic shape whilst tends to rotating. Because of that, durians need to be hold tightly to avoid it rotates while peeling. Second problem is durian is armed with sharp thorns that are fully capable of drawing blood. The potentially high risks of hand injury due to sharp thorns

are always present. And the last problem that needs to be encountered is high force need to be applied while peeling durian.

Common method of peeling durian using is using bare hand and a sharp knife. As common method to peel durian is not very appropriate due to its high risk of causing injury, many of people start to develop a new technique to peel durian. One of the examples is a groups of lecturers from Pusat Latihan Teknologi Tinggi (ADTEC) Batu Pahat developed an automatic durian peeler using pneumatic system named “Durian Peeler Machine” (Malaysia patent pending PI20062275). Another example of durian peeler was designed by the student from Pusat Latihan Teknologi Tinggi (ADTEC) Batu Pahat named “Durian Peeler” (patent pending 20062275).

Although there are many studies have been done to design a durian peeler machine, there are still no durian peelers that used ergonomics approach as their core for designing. Most of the designer were focusing on how to minimize the probability of getting hurt and shortens time of operation to peel a durian. An ergonomics study should be put into consideration as it will result bad effect to the operator of the machine for a long term.

Thus, this study is to design and develop durian peeler using ergonomics approach. Generally, ergonomics is a field of study that seeks to design tools, equipment and task to optimize the interface between human and system (Dan Macleod, 1998). This interface can be simple as that between human and a work table such as height of table, sharp edge on table and also foot rest if any (Dan Macleod, 1998).

1.2 OBJECTIVES

The objective of this study

- I. To design durian peeler with ergonomics approach using Solidworks.

1.3 SCOPE OF THE STUDY

Without yet considering unforeseeable problem that might crop up later, these are the exclusions and the thing known but not attempt to solve:

1. The developed durian peeler is only a prototype and is not readily functional as a commercial product.

1.4 PROJECT ASSUMPTION

This thesis is based on certain assumptions:

1. All anthropometry data are taken from Thailand anthropometry (Juruwan Klamklaya et al, 2006)
2. For the set up questionnaire, respondents are answering the questionnaire based on their daily working routine.
3. Dimension for typical durian size is 30 cm in length and 15 cm in diameters based on Malaysian Agricultural Research and Development Institute (MARDI).
4. Average durian weight is 1 to 3 kg (MARDI).
5. Machine is only for Small and Medium Enterprise (SME).
6. This machine is only used by the operator aged 18-25. This is due to the anthropometry data that are used for this study is only vary between aged 18-25.

1.5 PROJECT BACKGROUND

This project is to solve the musculoskeletal problem among the worker who manually peels the durian. Currently, there are very little studies have been done for such function. We are going to design a durian peeler that will do this by adapting the ergonomics criteria. In doing this, we are going to tackle some of the problems associated with the musculoskeletal disorders. Other problems are not tackled in the duration of this project.

1.6 THESIS ORGANIZATION

There are 5 chapters in this thesis and was organized as follows. For each chapter, there are sub-topics in it.

In chapter 1, the introduction consists of describing durian in a scientific way, problem in peeling durian, the studies, the purpose of this study. In addition, this section also includes the objectives of the study, the scope of study, the project assumption and the project background.

Chapter 2 is to gather useful information from journal, book and article that are related to ergonomics study. All of the information gathered from this chapter will be reviewed to design the durian peeler.

Chapter 3 is about methodology of the research design. This includes a methodology to complete this study such as questionnaire design, and other particular procedure used to complete this study. Justification on each of question is also noted in this chapter.

Chapter 4 is about analysis of collected data from the questionnaire. Each of the questions will be analyzed and the result will be used for designing a durian peeler. In this chapter also the comparison between previous designs will be discussed.

Chapter 5 will discuss about the achievement of the study and also recommendation regarding the project for the benefits in the future task.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The purpose of this chapter is to gather useful information from journal, book and article that are related to ergonomics study. Generally, this chapter has been divided into several sections. First section of this literature review will cover the history of ergonomics. Second section will discuss about principle of ergonomics that were taken into considerations for this study. Third section will cover on the previous studies on ergonomics design. In addition, this section also discusses about the previous durian peeler design. Fourth section will discuss about designing a survey. Fifth section will discuss about anthropometry data used. Besides that, CAD software will be discussed in general. All of the information gather from this chapter will be reviewed to design the durian peeler. The sources for the literature review are library books, journal from established databases such as Science Direct and Scopus, article and also newspaper article.

2.2 ERGONOMICS

This section will discuss about ergonomics including its definition and the history of ergonomics development.

2.2.1 Ergonomics: Definition

The word “ergonomics” is derived from the Greek Word “ergon” that means work and “nomos” that means law. In the United States, the term ergonomics is also known as “human factor”. A direct definition of ergonomics would be that ergonomics aims to design appliance, technical system and task in a way that can improve human safety, health and comfort without sacrifice the performance and efficiency for that particular design.

The formal definition for ergonomics (or human factor) is the field of study that seeks to design tools, equipment, and task to optimize the interface between human and system (Dan Macleod, 2006). Example of the interface is between human and table (sharp edge on table, height of table and also foot rest for the table (Dan Macleod, 2006).

Ergonomics emphasizes on equipment design and workspace design and the relevant subjects are anatomy, physiology, industrial medicine, design, architecture and illumination engineering.

2.2.2 Ergonomics: History

The term ergonomics was invented by Murell in 1949. Ergonomics started to develop and recognize during the Second World War when for the first time human sciences were systematically applied in a co-ordinate manner. At that time, physiologist, psychologist, medical doctor, work scientist, anthropologist and engineer together address the problem arising from the operation of complex military equipment. The result of this inter-disciplinary approach appeared so promising that the cooperation was pursued after the war in industry. In Europe and the United States, the interests in this approach grow rapidly. This lead to the foundation in England of the first ever national ergonomics society in 1949 and starting from that, term “ergonomics” was adopted. After that in 1961, International Ergonomics Association (IEA) was created. At that time IEA was represent ergonomics society which are active at 40 countries or region, with

total membership approaching 15000 people (Jan Dul and Bernard Weerdmeester, 2001).

After certain years, modern ergonomics was introduced. Modern ergonomics differ from conventional ergonomics as modern ergonomics only contributed to design and evaluation of work system and product. For conventional ergonomics, engineer designed a whole machine or product. Table 2.1 show the contribution of modern ergonomics in system design and management.

Table 2.1 Contribution of modern ergonomics in system design and management
(Jan Dul and Bernard Weerdmeester, 2001)

CONTRIBUTION OF MODERN ERGONOMICS IN SYSTEM DESIGN AND MANAGEMENT
<ol style="list-style-type: none"> 1. A standard format for describing human-machine systems 2. Identification, classification, and resolution of design issues involving the human component 3. Task and human-machine interaction analysis 4. Specification of system design and human behavior. Implementation of controls 5. Identification of core trend in human and biological science and their implications for system design and management 6. Generation of new concepts for the design and analysis of human-machine systems 7. Evaluation of the sociotechnical implication of design option

2.3 ERGONOMICS PRINCIPLES

This section will briefly discuss about the ergonomics principle that were taken into consideration for this study. Ergonomics principle are summarize for the field of ergonomics. There are 10 ergonomics principle will be discussed in this section (Dan Mac Leod, 2006).

1. Work in neutral posture

Work in neutral posture is important as working in awkward position increases fatigue and physically stress in the body. It also reduces strength and dexterity, thereby making task became more difficult to complete. There are several things need to be focused in neutral postures which are:

- Maintain the natural curve of the spine
- Keep neck aligned with body
- Keep elbow in and shoulder relax

2. Reduce excessive force

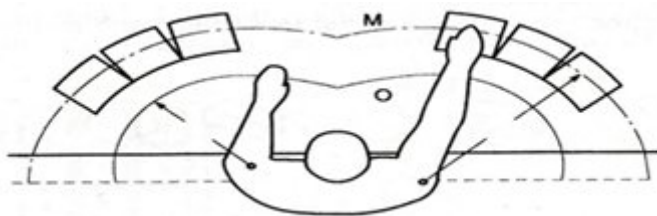
Reduce excessive force is also important in ergonomics. Excessive force can result to creating fatigue, overload muscle and cause injury. There are several ways that can be used in order to reduce force:

- Use levers
- Use conveyors
- Improve in grip design
- Change method
- Using body position to best advantage
- Fixtures and backstop

- Use Tool and machine

3. Keep everything in easy reach

In order to design a machine that user-friendly, machine part that frequently use need to be in reach envelope. Noted that, rich envelope is semi circle that arms make as it reach. Figure 2.1 show the illustration about reach envelope. There are 2 semi circle lines denoted by M and O in the figure. Capital M is represent by maximum reach envelope that can be achieved and capital O is represent optimum reach that can be achieved without neglecting ergonomics rules.



M = Maximum Reach

O = Optimum Reach

Figure 2.1 Reach envelopes (Bridger, 1995)

4. Work at proper high

Working at wrong high will lead to poor posture and related fatigue, discomfort, and potential damage to soft tissue. Generally, work is best done at about elbow height. However, working high is depending on the nature of work. For example, heavier work requiring upper body strength and it should position slightly lower than elbow height. For works that require high focus, working position should be higher than elbow position. Since people vary in height, the best solution for working height is by design a machine or workstation that can