

UNIVERSITI MALAYSIA PAHANG

BORANG PENGESAHAN STATUS TESIS♦

JUDUL: **A PRELIMINARY DESIGN OF PORTABLE PINEAPPLE PEELER: AN ERGONOMICS APPROACH**

SESI PENGAJIAN: 2009/2010

Saya **NOOR EFFENDY BIN MAT REJAB (870907-09-5191)**
(HURUF BESAR)

mengaku membenarkan tesis (Sarjana Muda/Sarjana/Doktor Falsafah)* ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hakmilik Universiti Malaysia Pahang (UMP).
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (√)

SULIT

(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

TERHAD

(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

TIDAK TERHAD

Disahkan oleh:

(TANDATANGAN PENULIS)

(TANDATANGAN PENYELIA)

Alamat Tetap:

**NO 29 A, KG GELAM,
KEDAWANG, 07000
LANGKAWI, KEDAH.**

NURUL SHAHIDA BT MOHD SHALAHIM
(Nama Penyelia)

Tarikh:

Tarikh :

- CATATAN:
- * Potong yang tidak berkenaan.
 - ** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali tempoh tesis ini perlu dikelaskan sebagai atau TERHAD.
 - ♦ Tesis dimaksudkan sebagai tesis bagi Ijazah doktor Falsafah dan Sarjana secara Penyelidikan, atau disertasi bagi pengajian secara kerja kursus dan penyelidikan, atau Laporan Projek Sarjana Muda (PSM).

UNIVERSITI MALAYSIA PAHANG
FACULTY OF MECHANICAL ENGINEERING

We certify that the project entitled A Preliminary Design of Portable Pineapple Peeler: An Ergonomics Approach is written by Noor Effendy Bin Mat Rejab. We have examined the final copy of this project and in our opinion; it is fully adequate in terms of scope and quality for the award of the degree of Bachelor of Engineering. We herewith recommend that it be accepted in partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering

(name of panel member)

Examiner

Signature

A PRELIMINARY DESIGN OF PORTABLE PINEAPPLE PEELER:
AN ERGONOMICS APPROACH

NOOR EFFENDY BIN MAT REJAB

Thesis submitted in fulfillment of the requirements
for the award of the degree of
Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

NOVEMBER 2009

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

Signature :

Name of Supervisor : Pn Nurul Shahida Bt Mohd Shalahim

Position : Lecturer

Date :

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.

Signature :
Name : Noor Effendy Bin Mat Rejab
ID Number : MA 06067
Date :

Dedicated to my beloved family

ACKNOWLEDGEMENTS

I am very grateful and would like to express my sincere gratitude to my supervisor, Madam Nurul Shahida Binti Mohd Shalahim for her outstanding cooperation and guidance in making this research possible. Her supervision had led this research to be completed within the estimated time. The support that she gave to me in solving all the problems that occur during the research is tremendously outstanding.

My sincere thanks for my friends in making this research possible. Without their thoughts and ideas in developing the design and analysis, the research would be wasteful. Also, to the staff of Faculty of Mechanical Engineering, Universiti Malaysia Pahang, especially to the lab instructors who had helps in the first stage of the design. To all the respondents that involve in the questionnaire, a special thanks for participating in the research.

Last but not least, special thanks to my mother and my late father for their never ending support to me for pursuing knowledge to the highest level. I acknowledge my siblings' understanding and support in terms of time and money for me to complete this project. With all of their support, I finally manage to solve problems occur during the research and manage to complete this research.

Abstract

This study is about designing a pineapple peeler using ergonomics technique in order to avoid or minimize the chance of developing Musculoskeletal Disorders (MSD) among pineapple peeler workers. MSD happens due to the product or tools that is not ergonomics. MSD starts to develop when a workers is doing a job repeatedly. Working tools that is not ergonomics combining with the repeated movement will results in MSD to develop and resulting pain in a long term period. There is two objectives for this study. The first objectives of this study is to design a portable pineapple peeler with ergonomics approach using Solidworks. The preliminary design will be design using Solidworks. The second objectives is to simulate the designed pineapple peeler using Algor. This is to analyze the for affecting the peeler when it is motion. In gathering the data needed for this study, questionnaire will be used to obtain information from the workers about the problems that they face when using their working tools. All the questions asked will be related to ergonomics concepts. Then the answers will be analyzed so that it will be used to design a pineapple peeler that have less problems against the workers from ergonomics point of view. The design stage will take two stages. The first one is based on literature review and the second stage will be based on the answers from the questionnaire. Basically the first design will be refined and improved in the second stage. The improve design will be analyzed using Algor to evaluate the force distribution on the critical part of the pineapple peeler when it is used by the workers. The force distribution will affect the human body and resulting in MSD. The usage of ergonomics in producing a product will helps to save life. The MSD will effect people in long term period and before they know it, it has gotten worst. Thus, the improved design of the pineapple peeler will minimize and reduce the risk of having MSD among pineapple peeler workers.

Abstrak

Kajian ini adalah mengenai mereka bentuk pengupas nenas mudah alih menggunakan pendekatan ergonomik demi mengurangkan risiko menghadapi Musculoskeletal Disorders (MSD) di kalangan pekerja pengupas nenas. MSD berlaku disebabkan oleh produk atau alatan bekerja yang tidak ergonomik. MSD bermula apabila seseorang pekerja melakukan sesuatu pergerakan secara berulang. Alatan bekerja yang tidak ergonomik ditambah pula dengan pergerakan berulang akan membawa kepada kesakitan yang berpanjangan. Kajian ini akan mempunyai dua objektif. Objektif pertama adalah mereka bentuk pengupas nenas mudah alih dengan menggunakan Solidworks. Rekabentuk awal akan menggunakan Solidworks. Objektif kedua adalah mensimulasikan penggunaan pengupas nenas mudah alih yang telah direkabentuk. Ini adalah untuk mengkaji tentang daya yang bertindak ke atas pengupas nenas semasa ia digunakan. Dalam mengumpulkan data untuk kajian ini, borang soal selidik akan digunakan untuk mendapatkan maklumat daripada para pekerja berkenaan masalah yang mereka hadapi semasa bekerja. Semua soalan yang diajukan adalah berkaitan mengenai ergonomik. Kemudian, jawapan mereka akan dikaji untuk menghasilkan sebuah pengupas nenas yang memberikan kurang masalah kepada para pekerja dari sudut ergonomik. Proses merekabentuk akan melalui dua peringkat. Peringkat pertama rekabentuk akan berdasarkan kepada teori dan kajian yang telah dilakukan sebelum ini manakala peringkat kedua akan berdasarkan kepada jawapan daripada borang soal selidik. Secara mudahnya, rekabentuk peringkat pertama akan ditambah baik pada peringkat kedua. Rekabentuk yang telah ditambah baik akan dianalisis menggunakan Algor untuk menentukan taburan dan tindakbalas daya pada bahagian kritikal pengupas nenas semasa ia digunakan. Penggunaan ergonomik dalam merekabentuk produk akan menyelamatkan nyawa. MSD akan member kesan kepada masyarakat dalam jangka masa panjang dan sebelum mereka ketahui, ia telah menjadi teruk. Sehubungan dengan itu, pengupas nenas yang direkabentuk akan meminimumkan dan mengurangkan risiko untuk mendapat MSD dikalangan pekerja mengupas nenas.

TABLE OF CONTENTS

	PAGE
SUPERVISOR’S DECLARATION	ii
STUDENTS’S DECLARATION	iii
ACKNOWLEDGEMENT	v
ABSTRACT	vi
ABSTRAK	vii
TABLE OF CONTENTS	viii
LIST OF TABLES	xii
LIST OF FIGURES	xiii
LIST OF ABBREVIATIONS	xiv
CHAPTER 1 INTRODUCTION	
1.1 Introduction	1
1.2 Problem Statement	3
1.3 Project Objectives	3
1.4 Project Scopes	3
1.5 Thesis Organization	4
CHAPTER 2 LITERATURE REVIEW	
2.1 Introduction	6
2.2 Ergonomics	6
2.2.1 History of Ergonomics	6
2.2.2 Ergonomics Definition	8

2.2.3	Principle of Ergonomics	11
2.2.4	Musculoskeletal Disorders	15
2.3	Peeling and Musculoskeletal Disorders	23
2.4	History of Pineapple	24
2.5	Pineapple Peeler	25
2.6	Microsoft Excel	28
2.7	Solidworks	28
2.8	Questionnaire	29
2.9	Literature Review Summary	29

CHAPTER 3 METHODOLOGY

3.1	Introduction	32
3.2	Data Collection Method	32
3.3	Questionnaire Design	33
3.4	Questionnaire Analysis	33
3.4.1	Questionnaire Justifications	33
3.4.1.1	Respondents Details	34
3.4.1.2	Working Style	34
3.4.1.3	Body Posture	35
3.4.1.4	Working Accessories/Tools	36
3.5	Sampling Design	38
3.6	Data Analysis	38
3.7	Designing	39
3.7.1	Preliminary Design Base on Literature Review	39
3.8	Simulation	42
3.9	Summary	42

CHAPTER 4 RESULTS AND DISCUSSION

4.1	Introduction	43
-----	--------------	----

4.2	Questionnaire Analysis	43
4.2.1	Respondent's Age	44
4.2.2	Respondent's Gender	45
4.2.3	Respondent's Number of Working Hours in a Day	46
4.2.4	Number of Working Years	47
4.2.5	Repetitive Movement	48
4.2.6	Enough Resting Time	49
4.2.7	Sitting For A Long Time	50
4.2.8	Discomfort When Sitting	51
4.2.9	Changing Workpiece Position	52
4.2.10	Resting of Upper Body After Hours of Working	53
4.2.11	Backpain While Doing Work	54
4.2.12	Pressure Experience At The Upper Body	55
4.2.13	Unchange Position During Working	56
4.2.14	Feels Comfort When Sitting	57
4.2.15	Bending the Hand While Doing Work	58
4.2.16	All Forces Is Directed To The Hand While Doing Work	59
4.2.17	Both Hand Is Kept Inside While Doing Work	60
4.2.18	Hands Movement While Doing Work	61
4.2.19	Adjusting The Working Tools To Be Fitted To The Hand	62
4.2.20	Tools handle Is Not Big Enough To Be Hold	63
4.2.21	Tool's handle Need To Be Wrap To Comfort The Worker's Palm	64
4.2.22	Force Use To Move The Workpiece	65
4.2.23	Working Tools Causing Pain To The Body	66
4.2.24	Working Tools Causing Discomfort To The Body	67
4.2.25	Adjusting The Workpiece For Comfort	68
4.2.26	Task Perform Produce Vibration	69
4.2.27	Satisfaction Against Current Working Tools	70
4.3	New Design	71
4.4	Design Comparison	73
4.5	Analysis of Design In Algor	74

4.5.1	Result for 10N	74
4.5.2	Result for 15N	75
4.5.3	Result for 20N	76
4.5.4	Result for 30N	77
4.5.5	Result for 40N	78
4.6	Results and Discussions Conclusion	79

CHAPTER 5 CONCLUSION

5.1	Introduction	80
5.2	Objectives Achieved	80
5.3	Contribution Of The Study	81
5.4	Limitations	82
5.5	Recommendations	82
5.6	Conclusion	83

REFERENCES	84
------------	----

APPENDICES

A	Questionnaire	89
B	Descriptive Answers For Questionnaire Section A,B,C,D	93
C	Technical Drawing	96

LIST OF TABLES

Table No.	Title	Page
2.1	Recent studies on ergonomics	10
2.2	Recent studies on ergonomics at work	14
2.3	Recent studies on Musculoskeletal Disorders	19
2.4	Recent studies on pineapple peeler	27
3.1	Respondent details question and justification	34
3.2	Working style question and justification	35
3.3	Body posture question and justification	36
3.4	Working accessories/tools questions and justification	37
3.5	Design Justifications	41
4.1	Comparison of design	73
4.2	Von Misses stress for 10N	75
4.3	Von Misses stress for 15N	76
4.4	Von Misses stress for 20N	77
4.5	Von Misses stress for 30N	78
4.6	Von Misses stress for 40N	79

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
2.1	Person with computer as working tools	9
2.2	Real person with ergonomics position	9
2.3	Infected are of pain when workers having MSD	18
2.4	Area near the hips is most likely to injures if MSD happens	18
2.5	Domestics pineapple peeler	26
2.6	Commercial pineapple peeler	26
3.1	Flow chart of methodology	31
3.2	Front view	39
3.3	Top view	40
3.4	Trimetric view	40
4.1	Respondent's age	44
4.2	Respondents' gender	45
4.3	Pie chart of percentage of working hours per day	46
4.4	Pie chart of respondents' years of working	47
4.5	Pie chart of repetitive movement	48
4.6	Resting time	49
4.7	Sitting for a long period	50
4.8	Discomfort when sitting	51
4.9	Changing workpiece position	52
4.10	Resting of upper body after hours of working	53
4.11	Backpain while doing work	54
4.12	Pressure experince by the upper body	55
4.13	Unchange position during working	56

4.14	Feels comfort when sitting	57
4.15	Bending the hand while working	58
4.16	Force directed to hand when working	59
4.17	Both hand kept inside while working	60
4.18	Hand movement while doing work	61
4.19	Adjusting the working tool to be fitted to the hand	62
4.20	Tool's handle is big enough to be hold	63
4.21	Comforting the palm	64
4.22	Force use to move the workpiece	65
4.23	Working tools causing pain to the body	66
4.24	Working tools causing discomfort to the body	67
4.25	Adjusting the workpiece for comfort	68
4.26	Task perform produce vibration	69
4.27	Satisfaction against the current working tools	70
4.28	Isometric view	71
4.29	Front view	71
4.30	Top view	72
4.31	Bottom view	72
4.32	Von misses stress for 10N	75
4.33	Von Misses stress for 15N	76
4.34	Von Misses stress for 20N	77
4.35	Von Misses stress for 30N	78
4.36	Von Misses stress for 40N	79

LIST OF ABBREVIATIONS

CTDs	Cumulative trauma disorders
MSD	Musculoskeletal disorders
N	Newton
SME	Small and medium enterprise
RSIs	Repetitive strain injury
RMI	Repetitive movement injury
RP	Rapid prototype

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Malaysia is one of the countries that has a lot of varieties of fruits. These fruits sometimes gives advantages in term of profit. Usually in Malaysia, fruits become one of the nations top export goods. One of the main fruits that has been exported for many years is pineapple.

The pineapple had become one of the items that generate profit to the country. It grow to become an industry in Malaysia. Small and medium enterprise (SME) is the business that actually correlated with the pineapple. Pineapple business has become a vital business in Malaysia and it has emerged ever since and has developed a small town into a big one in regards of the pineapple business. For example, Pekan Nenas Johor has developed due to the pineapple business. The business involved the local residents and since the business is small, the processing process is done manually by the workers. Manual process of peeling is by using bare hand and knife. Just like peeling pineapple at home.

The pineapple skin is thick and a person needs a lot of force and muscle usage to peel a pineapple. Peeling the pineapple skin is the most crucial part when processing a pineapple . For SME, this process is known to be a repetitive task since the workers will peel a lot of pineapples for a working period . In ergonomics, repetitive works actually causing a disease that we called musculoskeletal disorder (MSD). The MSD will affect the workers that the job specification involving repetitive movement. As we know, the peeling process involved the upper body of a person thus making the body vulnerable to back pain

and other MSD symptoms. For workers that repeatedly peel the pineapple, the most infected part would be the hand or known as the carpal. Gripping the tools or knife to peel and also the force experienced by the hand due to the effect of cutting force will eventually resulting in pain around the hand area.

Since the work is repetitive and it is been done frequently, this will effect the workers health. In long terms, the body part might not be able to function well according to its use. For example, the hand that is used for peeling, it is been subjected to the same force and the same area that is affected will result in severe damage. Common peeler such that for potato also gives affect to the user such as wrist pain. This is just for small fruit and domestic use that is at home and just for kitchen usage. Imagine using the same peeler for a pineapple. With much bigger force, much bigger size, so it tends to produce much more pain when doing the work. Even for domestic use we would feel the pain. How about the repetitive work that maybe reach about eight hours a day. Of course it will give effect that is much worse than daily kitchen work. When this happened, it will effect the workers' health and finally affect the company as well. The company will loss worker that's having a health problem. This means more work but less workers. This will cause the work to be delayed and worst causing bottleneck. Besides that, the company might have to pay compensation for the workers. If one worker it is ok, but if it affects many workers, it can affect the company's profit.

In order to overcome this problem, the ergonomics design can be used. This project will emphasizes on the use of ergonomics approach in designing a pineapple peeler. Nowadays, ergonomics has becomes an essential tools or knowledge in overcome MSD. This is because ergonomics has been proven to solve work related problems. In the peeling process case, ergonomics design will be used in order to find the right design and the right peeling style or work orientation for the workers since nowadays peeling fashion came across a lot of work related problems or in other words, ergonomics will help to ease the pain among the workers. This can be done by accommodating the ergonomics and also the efficiency of a peeler. Thus resulting in less pain and injury but more productivity.

Furthermore, this can benefit the company because the manual peeling method that is using hand and knife can be changed to a much faster way.

1.2 PROBLEM STATEMENT

This project is to solve the musculoskeletal problems among workers who manually peel the pineapple. Currently, there are very few studies have been done for such a function. We are going to design a pineapple peeler that will do this by adapting the ergonomics criteria. By 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.

1.3 PROJECT OBJECTIVES

The objectives of this study are:

1. To design a portable pineapple peeler with ergonomics approach using Solidworks.
2. To simulate the designed pineapple peeler using Algor.

1.4 PROJECT SCOPES

Without yet considering unforeseeable problems that might crop up later, these are the exclusions and the things known but not attempted to solve:

1. To developed pineapple peeler is only prototype and it is not readily functional as a commercial product.

1.5 THESIS ORGANIZATION

This thesis is been divided into five chapters and every chapter has its' own sub topics. The first chapter discusses about the introduction of the whole project idea. It also explains about the pineapple peeling process and the association of ergonomics as well as the importance of ergonomics when commanding a work . Brief explanation about pineapple in Malaysia is also included. Also included in the first chapter is the problem statement. The problem statement explain the problem faces when peeling process and also the limitations when doing this project. Not forgetting the scope as well as the project objectives.

In chapter two, literature review according to the terms involve with the project is done. Terms such as ergonomics, peeler and pineapple are among the main subject for this chapter. The explanation is based on the usage of ergonomics and it's connection to work. Also the importance of ergonomics as well as the brief history of pineapple and peeler and also the current and past research about the terms associated with the projects. The sources for this chapter are books, journal article, websites and newspaper articles.

Chapter three explains the methodology of the research. Methods on how the project is conducted will be explained and presented in this chapter. The method used will be focused on how the data is gathered through questionnaire. The principle of designing the questionnaire is also discussed in this chapter. The objective of the questionnaire will be further discussed in this chapter. The questionnaire will be based on the pilot questionnaire design at the early stage of the project.

In chapter four, data from the project will be analyzed and evaluated. Data will be gathered and discussed thoroughly. Data collected will be processed using Microsoft Excel (Microsoft) to determine the best approach for the design according to the information from the questionnaire and from the ergonomics approach. The discussion on the data will led to the designing of the pineapple peeler. The design will be based on two stages. The first one is based on the literature review while the second stage will account the answer

from respondents as well as the respondents answers. After that, simulation using Algor software will take place. The analyze will be on the critical parts that are affected by the force subjected to a certain part by the user.

The final chapter discusses the objective of the project is either achieved or not. Besides that, suggestion on how to improve the project and its' product will be pointed out. Furthermore , all the problems that happen during this project will be briefly explained and also will be included with solution to the problem.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discusses about the previous researches that have been done about the related issues with this project. Definition of each term will also be included. Ergonomics, musculoskeletal disorders, pineapple and pineapple peeler are among the interested terms in this chapter. The source of the review are extracted from journal, article and books. Literature review is done to provide information about previous research and the relevant that can help to smoothly run this project.

2.2 ERGONOMICS

2.2.1 HISTORY OF ERGONOMICS

In the early 1900's, the production of industry was still largely dependent on human power/motion and ergonomic concepts were developing to improve worker productivity. Scientific Management, a method that improved worker efficiency by improving the job process, became popular. After World War II, the focus of concern expanded to include worker safety as well as productivity. Research began in a variety of areas such as:

- Muscle force required to perform manual tasks
- Compressive low back disk force when lifting
- Cardiovascular response when performing heavy labor

- Perceived maximum load that can be carried, pushed or pulled

Areas of knowledge that involved human behavior and attributes (i.e., decision making process, organization design, human perception relative to design) became known as cognitive ergonomics or human factors. Areas of knowledge that involved physical aspects of the workplace and human abilities such as force required to lift, vibration and reaches became known as industrial ergonomics or ergonomics.

(<http://www.ergoweb.com/resources/reference/history.cfm>)

It seems like ergonomics has been around for many years and it has been improved without we realizing it. This is because at that time we were not actually using ergonomics as the standard terms but actually after the gathering in England that has give birth to the ergonomics field.

According to Lehto and Buck (2008), the field got it's name in summer of 1949 when a group of interests individuals assembled in Oxford, England to discuss the topic of human performance. The group consists of anatomists, physiologists, psychologists, industrial medical officer, industrial hygienists, design engineers, work study engineers, architects, illuminating engineers, and anyone who is concerned some aspect of human performance. Then it is decided that they would coin new word ergonomics, which couples ergos, the greek word for work and momos, meaning natural laws. Some time later, the term human factors was coined in U.S for a society of similar purpose.

Through this, we can say that ergonomics also happens to be the human factors. Human factors focused more on the human itself. When doing a certain job like lifting a box, all aspects of the human body will be inspected. This is to determine whether the job that has been given is actually causing pain to the worker. If it is, then solution has to be done in order to minimize or reduce the health effect among workers. Human factors also related to the bone, muscle and the biomechanics of human body. By observing the human movement and how they work, we can actually design a job that is fit for someone. That is according to the terms ergonomics itself that is fitting the job to the workers. The most

important aspects of ergonomics is how to design work and workplace that is safe for workers. If we can design workplace that is safe for workers, then it will be good for the workers and the company. Besides that, if the worker is having health problem due to the workplace environment and the work itself, the company has to pay compensation to the workers. This will burden the company as they have to pay money and subsequently losing their workers in terms of working hands. This is actually because of musculoskeletal disorders (MSD).

2.2.2 ERGONOMICS DEFINITION

“Ergonomics (or human factors) is the scientific discipline concerned with the understanding or interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance” (Helander, 2006). By the definition, we can conclude that ergonomics is actually a science discipline to obtain working environment that is fit for people to work. It is also making the job to be fit to the worker. That is why it is stated in definition that ergonomics is also designing jobs and work related material. Meaning that we are trying to create a job that basically does not affect human health. Figure 2.1 shows a person who is using the computer as working tools. Besides that, it also shows the position that the person is sitting and how the body reacts towards the working tools. The chair that the worker is sitting on gives the body posture and this will show the position that will give MSD. In figure 2.2, it shows the real position that the worker should be according to ergonomics principles. It shows the seat angle and back cover that the chair should be designed. The chair design also gives the knee angle 90 degrees bend in order to support the legs. Besides that, the chair also focuses on the viewing angle and the viewing distance that the worker should have in order to prevent MSD.

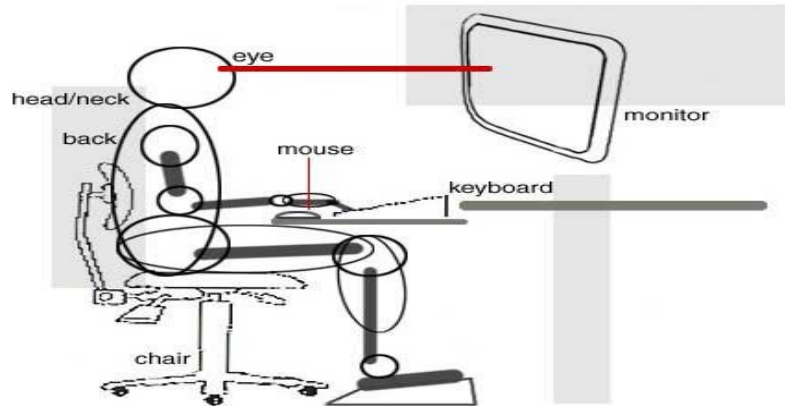


Figure 2.1: Person with computer as working tools

Source: www.medicaldistribution.com/mac2009

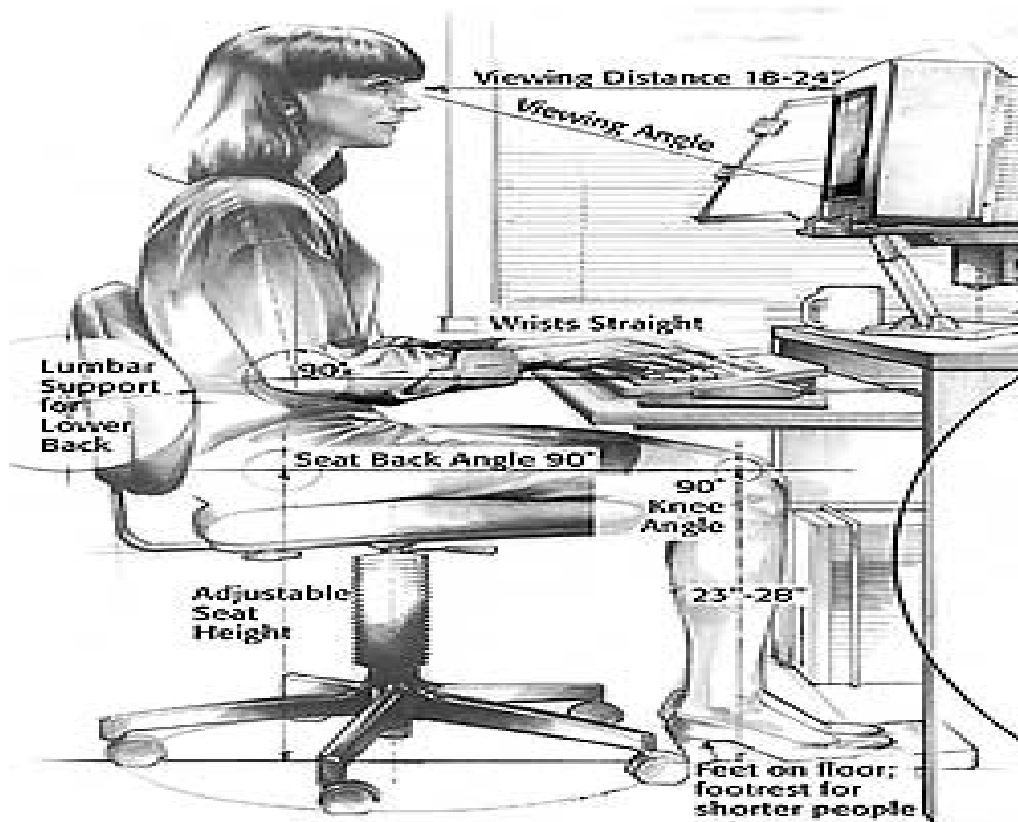


Figure 2.2: Real person with ergonomics position

Source: (<http://www.ergoweb.com/resources/reference/history.cfm/April2009>)

Statistics from the Ministry Human Resources Malaysia stating that in 1997, 86589 cases of accidents has been reported but in 1998 the cases reported had decline to 53339. Although there is a declination in the cases, we must always beware and try to take responsibility in avoiding such accidents from happening. It is also stated that the accidents happened basically because of the workplace is not ergonomics and consists of to many people in doing a job at the same time whereas the schedule for work has not been resolve carefully. Table 2.1 shows the recent studies on ergonomics.

Table 2.1: Recent studies on ergonomics

Year	Title	Author	Content
2000	Ergonomics definition	The ergonomics society	Ergonomics is a science of matching the design of tools, systems, equipment and the environment to the needs of the people who use them. It is the process of accommodating the job to the person- not the person to the job
2006	Kodak's ergonomics design for people at work	S.N.Cenghalur, S.H. Rodgers, and T.E.Bernard	Ergonomics is a multidisciplinary activity striving to assemble information on people's capacities and capabilities and to use that information in designing jobs, products, workplaces and equipment
2008	Introduction to human factors and ergonomics for engineers	M.R.Lehto and J.R. Buck	Ergonomics is the study of people at work

From the previous research, an ergonomics is trying to improve the existing design products that are being used right now. Accommodating for the pineapple peeler, the

product in the market needs to be changed in terms of design so that it can be more ergonomics and much more easy to use. By this, we can improve the performance of the workers and enhance the efficiency of the workers so that the productivity can be increased besides avoiding injury among the workers.

2.2.3 PRINCIPLE OF ERGONOMICS

In ergonomics, there are principles that must be followed in order to design the work that can be fit to the worker. The principles are safety, comfort, ease of use, productivity/ performance and aesthetics (Dul and Weerdmesster, 2001).

The first one is safety. Safety is very important since it is an element that everyone is looking for when performing a task. Ergonomics promote safety in designing the task for a worker. Job that is safe is relevant and practical to be used in the world. This is because the safety of the workers is guaranteed. Safety also includes the working environment and also the working tools. For working environment, a safe environment is very important. This is because workers can concentrate more on their task rather than thinking about their safety. Besides that, risky job environment like underground tunnel, undersea exploration and many more required high level of safety. That is for the workers to feel safe. For working tools, they need to be safe to be handle. That is why a lot of tools that move around is been equipped with safety measurements. Some tools for example the lathe machine is equipped with emergency stop button and also automatic emergency stop button. The emergency stop button is important in case something bad happen and the machine needs to stop immediately.

Comfort is also one of ergonomics principle. Comfort is known to be one of most desired criteria in designing a product. Everyone in the world wants the comfort in performing task. Working in a comfort environment tends to motivate the workers to work hard. Furthermore, it can relax the workers and release the stress that can cause ergonomics failure among the workers. Working accessories like chair, work bench, tooling apparatus are also need to be comfortable to be used. If the workers needs to adjust the chair for a

certain period of time before starting the work, this will cost the time of productivity for the company. Ergonomics principle tends to provoke comfort in working area. For example, a certain of the body needs to be in the comfort zone in order for the workers to do work. For an office workers that use computer, the spine needs to be in the comfort zone in order for them to operate in front of the computer for a long time. That is why the backrest of a chair usually been equipped with soft material to dampen the back of the body.

The third principle is ease of use. The ease of use usually related with the working accessories and tooling equipment. There are a lot of working accessories that associated with jobs. Different type of job required different type of working accessories. But one thing that is the same for all the accessories is the fact that it needs to be ease of use. Easy to say that it is easy to be use. Tools that is easy to be handle will enhance the efficiency of a worker. Imagine a handle bar that is hard to grip. This tends to make the user to make adjustment in order to adjust themselves to the working tool. Tools that is hard to use will make the task perform not ergonomics. This is because the workers will feel the stress that come from the difficulty of using the tools and also from the task perform itself. Besides that, tool that is not easy to be used will cause musculoskeletal disorders (MSD). MSD That is way it is important to make tools and working accessories to be ease to use.

Productivity and performance is also one of the ergonomics principle. Productivity is correlated with performance. If a performance of a worker is good, so as the productivity. We can say the performance is directly proportional to the productivity. Performance of a workers lies within the working aspects including the ergonomics itself. In order to produce productivity and performance, ergonomics will design job that will be fit to the workers according to the basic needs. This is important because if a worker like his or her job, then the productivity will be high, thus stimulate the potential in a person. Ergonomics will enhance the workers potential in doing the work and also manipulating the potential to increase the productivity of a worker. Ergonomics create conducive environment for working thus making the workers feels happy about their job. Besides that, performance and productivity is also vital in a company. The company's reputation will be based on the workers performance that will reflect the strength of a company.

The final one is aesthetics. Aesthetics of beauty is commonly about things like clothes, cars and many more. Everyone like things that is beautiful. Due to the fact beautiful thing is wanted in the world, ergonomics implement this part for the needs to produce jobs that can be fit to the workers. Although beauty is subjective, but it enhance a person's performance. Aesthetics values or beauty are usually associated with tools that is related to the job. Even chair needs to be aesthetics in order for it to be sold as well as to be liked. Making the workplace full of aesthetics value will cause the workers feels less stress when doing the job. It can also be thought as psychology measure in attracting ones' interest. For example, workers that work with computer, they need to have desktop or workplace that have aesthetics values. The attraction is more concentrated to the work by this way. Besides that, the shape of the tools also called aesthetics. Sometimes, we can see that many shape for a mouse or casing of a CPU. This is due to the aesthetics value that the designer use in designing.

The five principle in ergonomics is the core for every work that is designed according to ergonomics. Combining the principle in a single task will ensure that the worker will produce a good result in their work. Ergonomics design will prevent work related disease such as MSD and many more in working area. Through research that has been done, the principle is well known to be effective in solving problems of ergonomics at work. Table 2.2 shows recent studies on ergonomics.

Table 2.2: Recent studies on ergonomics at work

Year	Title	Author	Content
2002	Does ergonomic equal safety	Jonathan Tyson	Revise the connection of ergonomics and safety,
2006	Ergonomics experiment for thumb keyboard design	Xiong Yunfei	Study on how to improve the already made products, implement ergonomics principle on the product.
2007	The effects of job performance on effectiveness	Ermin Yahya	Evaluate performance on effectiveness, teamworking benefits of improving performance
2007	Ergonomics: Making the job fit	Laura Hill	Ergonomics usage in designing jobs for workers.
2008	Vibration reduction of pneumatic percussive rivet tools: Mechanical and ergonomic design approaches	John C Cherng, Mahmut Eksioglu, Kamal Kizilaslan	Solve ergonomics problem using Taguchi method, increase workers performance using ergonomics principle.

Solving work related problems using ergonomics can benefits the employer and the employee as well. This is because both sides are connected to each other. From the ergonomics study, we can say that the design must be according to the ergonomics principle. This is important so that we can reduce the problems that is related to the workers that happen due to design that is not ergonomics. This means the pineapple peeler must be comfortable and easy to use. Thus increasing the productivity of the workers.

2.2.4 MUSCULOSKELETAL DISORDERS (MSD)

Musculoskeletal disorder means a broad range of conditions of varying degree associated with the upper extremities (hand and arm) such as inflammation or trauma mostly of the tendon, muscle-tendon junction or surrounding tissue; inflammation of tissue of the hand, compression of the peripheral nerves serving the upper limb, and include temporary fatigue, stiffness of the muscles comparable to that unaccustomed exertion. (Prichett, 2004)

The MSD is actually a class of disorders that basically amount of wear and tear on the tissue surrounding the human joints. Every joints in the body can potentially affect , but the lower back and the upper limbs are the areas of most concern. MSD also occur because of having the repetitive work and also lifting. This causes fatigue and failure among the human tissue (Macleod, 2006). This means that working style that involve movement and repetitive work are potentially causing MSD. This is because the body is doing the same task the same way and the affected area would be the same. When an area is been subjected to the same force everyday, the area would become less efficient due to the fatigue experience by the body. For example, the hand when it is subjected to the same force every day will become weak. A person might also experience pain and also soreness around the effected area.

MSD cases has been reported through out the year. This means, the worker is gradually been attacked by this disease. MSD can affect a workers productivity and efficiency. This is because when a worker is having MSD, this means he or she has to take a leave in order to recover from MSD. But through out the year, thousand of workers have been infected by this disease. The worst case scenario would be the company would have to pay compensation to the workers. Macleoad (2006) also stated that the commoms MSD symptoms are:

1. Cumulative trauma disorders (CTDs)
2. Repetitive Strain Injuries (RSIs)
3. Occupational overuse symptoms

The disease stated has shown that working causes pain at all body parts. Although it can be treated, but if it repeatedly occurs at the same point and causing the amount of pain to be multiplying, then solutions must be find to reduce the pain. The MSD is a common disease in ergonomics and have been studied for years to overcome it. But the reality is different, workers are relatively hooked up to this problem at the workplace.

From Chengular (2006), around the same time, formal expectations were established about the programs and the processes that would be used to focus on proactively improving workplace environment and concomitantly reducing the risk of musculoskeletal disorders. In order to meet this, company's performance standard encompass the following basic tenets:

1. Employees should receive training in basic ergonomics principle. The aspects covered in the training depend on the work environment they have.
2. Employees whose activities impact the work environment (e.g,engineers, supervisors, maintenance groups, and health and safety professional) should receive in depth training commensurate with their activities.
3. Newly designed or modified workplace, processes, and equipment should meet established ergonomics or human factors guidelines.
4. A continuous improvement process should be used to reduce fatigue and human error, as well as the risk of injury associated with the existing workplaces, processes or equipment.

5. Affected employees should be involved in the planning and implementation of changes of workplace, equipment, or processes.
6. Reports or work related injuries and illness should be followed up with root cause analyses, and the workplace, process, or equipment should be modified accordingly.

The standard was basically for the company to practice so that ergonomics environment can be created and also that the workers are actually aware of ergonomics factors and what they can do to prevent MSD. This can also prevent further losses to the company not to mention they had to pay compensation to the workers if anything bad happen to them. A company needs to implement ergonomics working environment so that every worker will feel safe. This is important because environment that is not ergonomics can cause an expected injury. This situation will affect the productivity of workers and finally affecting the company in terms of profit. Experienced worker is not easy to find and the guidelines can reduce the stakes or risk that a company has to bear about losing experienced workers. Many companies nowadays are trying to implement an ergonomics working environments because it can increase the effectiveness of workers and also encourage the workers to work hard. Besides that, this will show that the company actually care about their employee. MSD among workers has been the top issues that is currently being discusses around the world. Due to the concern for the workers, such guidelines are needed. MSD rate around the world nowadays is high. Due to the lack of awareness among the workers itself that cause such situation to occur.

Figure 2.3 shows the area that is infected by pain when the workers are having MSD. The back pain is the most critical area and this will affect the workers performance. This phenomena happens due to the repetitive works that the workers involve. In figure 2.4, it shows the area of the spine that is most affected. The area near the hips is most likely to injure if MSD happens.



Figure 2.3: Infected area of pain when workers are having MSD

Source: <http://www.ergoweb.com/resources/reference/history.cfm>

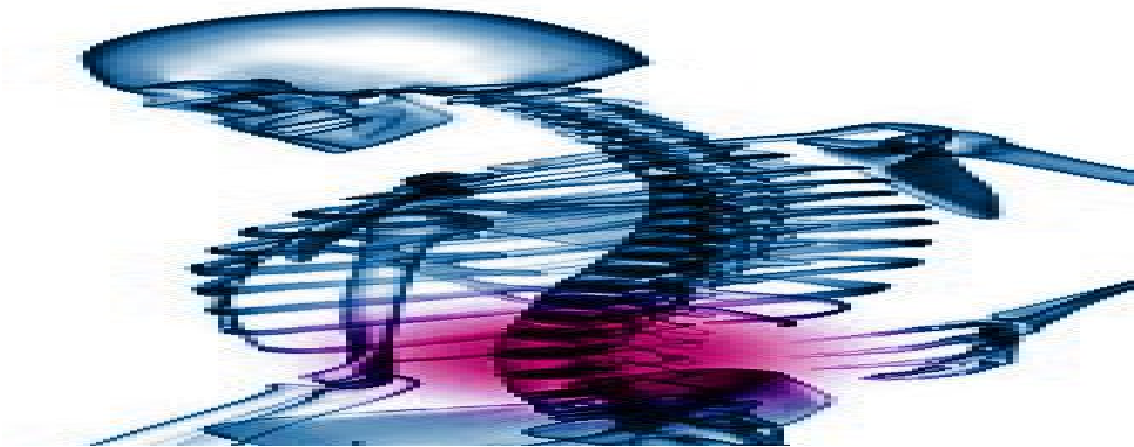


Figure 2.4: The area near the hips is most likely to be injured if MSD happens.

Source: <http://www.ergoweb.com/resources/reference/history.cfm>

Table 2.3: Recent Study on Musculoskeletal disorder (MSD)

Year	Title	Author	Content
2007	Posture and muscle activity of pregnant woman during computer work and effect of an ergonomic desk board attachment	Genevieve A. Dumas, Tegan R, Upjohn, Alain Delisle, Karine Charpinteir, Andrew Leger, Andre Plamondon, Erik Salazar, Michael J.McGrath.	Comparing posture and muscle activity in the back and upper extremity of late pregnancy and non pregnant controls. The research also evaluate the effect of concave desk board on the back and upper extremity of woman in late pregnancy.
2008	Force in measurement in field ergonomics research and application	Stephen Bao, Peregrin Spielholz, Ninica Howard, Barbara Silverstein.	Expalin the effect of pulling/pulling, lifting, pinch and power gripping, measure force when performing task.
2007	Posture and muscle activity of pregnant woman during computer work and effect of an ergonomic desk board attachment	Genevieve A. Dumas, Tegan R. Upjohn, Alain Delisle, Karine Charpinteir, Andrew Leger, Andre Plamondon, Erik Salazar, Michael J.McGrath.	Comparing posture and muscle activity in the back and upper extremity of late pregnancy and non pregnant controls. The research also evaluate the effect of concave desk board on the back and upper extremity of woman in late pregnancy.

Table 2.3: Continued

Year	Title	Author	Content
			<p>Properly textured handles increase the feeling of control on a powered tool; handle material with low thermal conductivity may also be desired.</p> <p>5.Reduce the vibration from the powered hand tool as far as practicable.</p> <p>6.Avoid gripping requirements in repetitive operations that spread the fingers and thumb apart more than 6.25 cm (2.5in) (Hertzberg,1955). Cylindrical grips should not exceed 5 cm (2in) in diameter (Pheasant and O’neill 1975), with 3.75cm (1.5in) as the preferable size (Ayoub and LoPresti 1971). Hand tools that produce vibrations, require wide grip spans, or repetitively abrade the wrist area during use of particular concern (Greenberg and Chaffin 1977)</p> <p>7 .For repetitive operations that require finger pinches, keep the forces below 10 newtons (2.2lbf). For gripping actions, keep the</p>

Table 2.3: Continued

Year	Title	Author	Contents
			required forces to 21 newtons (4.81lbf). These represent 20 percent of the isometric strength of the woman.
2007	Posture and muscle activity of pregnant woman during computer work and effect of an ergonomic desk board attachment	Genevieve A.Dumas, Tegan R. Upjohn, Alain Delisle, Karine Charpinteir, Andrew Leger, Andre Plamondon, Erik Salazar, Michael J.McGrath.	Comparing posture and muscle activity in the back and upper extremity of late pregnancy and non pregnant controls. The research also evaluate the effect of concave desk board on the back and upper extremity of woman in late pregnancy.
2008	Force in measurement in field ergonomics research and application	Stephen Bao, Peregrin Spielholz, Ninica Howard, Barbara Silverstein.	Explain the effect of pulling/pulling, lifting, pinch and power gripping, measure force when performing task.
2008	Physiological and perceptual responses in male Chinese workers performing combined manual materials handling tasks	Kai Way Li, Rui-feng Yu, Yang Gao, Rammohan V. Maikala, Hwa-Hwa Tsai.	Study the repeatiting task that the workers experience. The research also considering the effect of time expose to the task perform and the relation to MSD.

Table 2.3 Continued

Year	Title	Author	Contents
2008	Effects of ergonomics-based wafer-handling training on reduction in musculoskeletal disorders among wafer handlers	Hsin-Chieh Wu, Hsieh-Ching Chen, Toly Chen.	MSD effect on workers, Judge whether MSD prevention is worth or not in a certain job area.
2008	Comparing dynamic and stationary standing postures in an assembly task	Kai Way Li, Rui-feng Yu, Yang Gao, Rammohan V. Maikala, Hwa-Hwa Tsai.	Study MSD among factory assembly line workers. Effect of MSD to the productivity

From the previous studies we can say that tools and workplace that are not ergonomics will cause MSD and work-related problems. These problems will effect the workers performance and give bad effect to the employer as well. As we know, the design and work place that are not ergonomics will cause difficulties in terms of moving and performing the task for the workers. For the pineapple peeler, the design should enhance ergonomics principle and helps the workers to use it easily. This is very important so that the design will reduce the cause of injury to the workers.

2.3 PEELING AND MUSCULOSKELETAL DISORDERS

Nowadays, the method of peeling that is well known is by using bare hand and knife to peel of the fruit skin. For a pineapple, the peeling movement require a person to move up and down the hand by applying force to it. As we all know, the pineapple skin is thick and it is not easy to peel the skin off. Due to that, after one pineapple is peeled, a person will feel the pain around the hand and the upper body including the arms. The pain that a person experience is called musculoskeletal disorders (MSD). The MSD that happened due to the repetitive movement is called repetitive movement injury (RMI). There are many other terms, such as overuse disorder, musculoskeletal disorder, work related disorder, repetitive stress or strain and motion injury (Helander, 2006).

Peeling procedure that is for domestic does not tend to provoke MSD. This is because MSD is caused by repetitive movement. This means when the peeling is been done repeatedly, MSD will occur. SMEs are actually among the main group that still practice traditional peeling method. Because of this, a lot of pineapple workers that involve in peeling process are experiencing MSD. When peeling, the hand is been subjected to a force to drive the tools. The part of the hand is repeatedly been subjected to the same force and at the same spot. This will cause fatigue and from time to time, the worker will fell the pain from it.

Besides that, the tools provided for the peeling process is not ergonomics. Workers only provided with a knife and a glove to hold the pineapple. The knife handle is the part where the design is not ergonomics to hold. Changing the design to a more ergonomics handle will comfort the user and reduce MSD problems. Changing the peeling technique from up and down to a cyclic movement like a handle bar rotation will change the hand movement and equally distribute the force around the handle and the hand palm making less force experience around the hand.

2.4 HISTORY OF PINEAPPLE

Ananas comosus is the botanical name of the fruit we know as the pineapple. Native to South America, it was named for its resemblance to a pine cone, the pine cone reference first appearing in print in 1398. The term *pineapple* (or *pinappel* in Middle English) did not appear in print until nearly three centuries later in 1664. Christopher Columbus is credited with discovering the pineapple on the island of Guadeloupe in 1493, although the fruit had long been grown in South America. He called it *piña de Indes* meaning "pine of the Indians." ([http://homecooking.about.com/od/foodhistory/a/pineapplehist.htm/April 2009](http://homecooking.about.com/od/foodhistory/a/pineapplehist.htm/April%2009))

Pineapple has been around the face of the earth for a very long period of time. The seed of pineapple itself has been traveled around the globe. This situation contribute to the disperse of the pineapple. That is why we can see that every part of the world has pineapple even in Africa.

In Malaysia, pineapple had come since the invasion on Melaka. The Spaniard and the Portuguese did not only bring cultural and religion, but also pineapple. Attracted by the colour and tasty feature that the fruit have, the local start to grow them. This lead to the spreading of pineapple through out the region of Melayu. Pineapple has become one of the Malaysia's products in terms of business. The government had taken advantage in it by providing small and medium enterprise (SME) capital scheme to start agricultural business that is based on pineapple. Due to that, Pekan Nenas Johor has been dedicated to grow and produce pineapple product such as jams, pineapple juice and many more.

From the outside, the skin of the pineapple has dark green colour and some thorn like leaf. On top of the fruit, there is a crown like figure. Some people recognized it as the trademark for pineapple since it is the only one in the world that have that feature. The skin itself is thick and a lot of force is needed to peel off the skin. The shape of the fruit would be some kind like an oval. After peeling off the skin, a yellow layer of the pineapple skin will reveal. This is the part of the pineapple that you can eat. But before that, we have to cut

of the thorn like skin that is embedded in the yellow skin. After that, the pineapple is ready to be eaten.

There are many types of pineapples. Such common types are Hilo, Kona Sugarleaf, Natal Queen, Pernambuco and many more. The Spanish, Cayenne, and Queen is the most well grow because of it capability to grow at any kind of climate. In Malaysia, it is commercially grow to support the pineapple industries. Pineapple averages' weight is two to four kilograms. Pineapple is also known to grow to 30 to 100 centimeters while the averages diameters would be 12 to 15 centimeters (www.fama.com.my/mac2009).

Pineapple has a lot of nutritional that is good for human. The pineapple fruit has many beneficial effects to the human body. Pineapple contains the protein digesting enzyme mixture called bromelain. This enzyme is natural anti-inflammatory that encourages healing (http://www.healthmad.com/Nutrition/Nutritional-Benefits-of-Pineapple.66001/April_2009). This information shows that the pineapple has a lot of benefits to human. It can also be the source for medicine and suitable for patient that is on a recovery time.

2.5 PINEAPPLE PEELER

A peeler is a metal blade attached to a wooden, metal or plastic handle that is used for peeling certain vegetables, frequently potatoes, and fruits such as apples, pears and many more. There are a lot of peelers in the market that are mainly used to peel fruit skin. Potatoes and apple peelers are very common among the customer. The pineapple peeler however is not commercially sell and still undergo research to improve it. This is mainly because the size of the pineapple itself is big and it is not suitable to be peeled like potatoes and apples. The traditional peeling technique for a pineapple is actually by using knife and bare hand for peeling. This means the hand will be a part of the moving tools that will peel the pineapple.

In history, there are a lot of peeling techniques that have been invented to peel the fruit. The most famous one is Dalson Classic Aussie Peeler. It consists of a plastic handle which extends upwards to support both the base and tip of a partially rotating blade. This type of peeler is also typical of a general fruit and vegetable peeler in Canada. (Ranken, et al 1997.). This technique usually suitable for small fruit. It's difficult to fit it to pineapple. Figure 2.5 shows the potato peeling technique. This is the Dalson classic aussie peeler. Figure 2.6 shows commercial pineapple peeler develop by REITECH Co.



Figure 2.5: Domestic pineapple peeler

Source: www.ecw.com/mac 2009

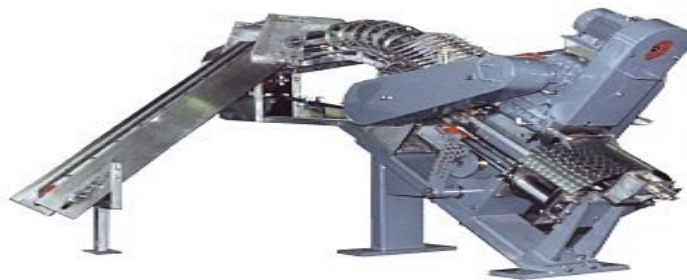


Figure 2.6: Commercial pineapple peeler

Source: www.reitechco.za/ April 2009

In the market, a device called pineapple corer has been designed to peel the pineapple. It uses mechanism of coring the flesh of the pineapple by making hole in the pineapple flesh and take out the remains. By that, it will remove the skin and also the thorn stem as well. But, it will take a thick skin from the outside because of the depth of the thorn stem is deep.

Table 2.4: Recent study on pineapple peeler

Year	Author	Title	Content
1993	Reitech SA	Pineapple peeler machine	Commercial pineapple peeler. Provide 65 to 100 accurately peeled and cored pineapple cylinders of various diameters per minute.
2005	Paul Ochom	Pineapple peeler	Produce a portable pineapple peeler for agricultural sector in Africa. Basically all assumptions of design based on hygiene and fast working procedure. Compared machine peeling and manual hand peeling method.
2008	ADTEC	Pineapple peeler	Pineapple peeler for SME business, capable of peeling over four tons of pineapple a day, Price estimated Rm6000.

The pineapple peeler in the market is using the coring mechanisms. The coring mechanism actually making a hole in the pineapple and taking out the flesh. This will left many flesh from the pineapple at the skin. As we know, the eye of the pineapple is located deep in the pineapple. Using the coring technique will actually cut too deep and not economical. Thus, the design is not only adequate for the ergonomics factors, but also economical to be used.

2.6 MICROSOFT EXCEL

Microsoft Excel is a spreadsheet-application written and distributed by Microsoft for Microsoft Windows and Mac OS X. It features calculation, graphing tools, pivot tables and a macro programming language called VBA (Visual Basic for Applications). It has been the most widely used spreadsheet application available for these platforms since version 5 in 1993.

In this project, the Microsoft excel is used to analyze the data that we get from the questionnaire. The distribution of the answer and the relevant answer that the respondents want for the design will be analyzed using this program. Graph and pie chart are among the answer distribution analysis that will be used.

Using graph, we can see which answer is the best according to the highest value of the graph. Besides that, we can compare which data is relevant according to the ergonomics principle and then design the pineapple peeler properly. Furthermore, the pie chart is use as the same principle of the graph. Using these two features in Microsoft excel can improve the accuracy of the result that we get because we can compare it with one another.

2.7 SOLIDWORKS

In the designing stage, we need a software that can visualize the 3D image of the peeler. Using Solidworks as the platform to develop the design gives a lot of advantage in terms of animation, view and needs to change the design. The animation feature can give basic view of how the design will function. This means we can design the peeler to be ergonomics and according to the respondents needs.

Solidworks is a 3D mechanical CAD (computer-aided design) program that runs on Microsoft Windows and was developed by Solidworks Corporation and now a subsidiary

of Dassault Systemes, S. A. (Velizy, France). It is currently one of the most popular products in the 3D mechanical CAD market.

This software will be used to design the pineapple peeler. The first stage will be designing the pineapple peeler according to the literature review. After the data from the questionnaire has been analyzed, we will refine the design according to the respondents needs.

2.8 QUESTIONNAIRE

Questionnaire can reach a large number of respondents. This means more data can be obtained and more accurate design steps can be taken. Besides that, the questionnaire is ease of use. This mean the respondents need only a few minutes to complete the questionnaire and then return it to the researcher. It does not required interviewer like interview and efficient it in terms of short time. Furthermore, the questionnaire has low cost advantages compared to interviews. We just needs few hundreds of questionnaire to be distributed and can reach many respondents in just a minute.

Interview is also one of the ways to collect data from people. Interview is different from questionnaire because interview offers a direct interface between interviewer and the respondent. This means the questions asked will be answered based on open-ended question and not close ended question like the questionnaire. Kumar (2005) stated that interview is useful in collecting in depth information. By this the interviewer can collect data by non verbal reactions and not depends on the scale or rating that has been set by the researcher like in the questionnaire.

2.9 LITERATURE REVIEW SUMMMARY

From the literature review, there is a relationship between the MSD, workplace ergonomics and tools design. According to ergonomics, job is designed for people, that is fitting the job to a person. Besides that, ergonomics is also co-related with safety. This is because MSD occurs to the workers often and produce an unsafe environment for the workers. MSD basically relates to the movement of a person. Repetitive movement is among the main source of the MSD. Cumulative trauma disorders and occupational overuse symptoms are also the main source of MSD. In order to prevent MSD, repetitive work is designed to be ergonomics in terms of working procedure and working tools. The tools is designed to be ergonomics to the workers. By doing this, MSD and the risk of injury is reduce.

Nowadays peeling technique are causing MSD among the workers. This is because the existing technique is not ergonomics and injury happened frequently. The traditional peeling technique that is using hand and knife to peel off the pineapple skin is not healthy and also affecting the productivity of a worker. This is because the technique is causing MSD and when the worker is having MSD, the speed of peeling will slow down due to the pain that they experienced. Changing this technique and working tools can reduce this pain.