UNIVERSITI TEKNIKAL MALAYSIA MELAKA

HAND TOOL ASSESSMENT OF AN OBJECT HANDLING TASK

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

by

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

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DECLARATION

I hereby, declared this report entitled "Hand Tool Assessment of an Object Handling Task" is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the Degree in Bachelor of Manufacturing Engineering (Manufacturing Management). The member of the supervisory committee is as follow:

………………………………

Supervisor

ABSTRAK

Projek ini adalah berkaitan penilaian terhadap alatan tangan untuk tujuan pengendalian objek lain. Tujuan projek ini dilakukan untuk menilai alatan tangan yang berfungsi untuk mengendalikan sesuatu objek yang panas. Terdapat dua alatan tangan yang akan dinilai iaitu alatan tangan yang mempunyai rekabentuk lama dan alatan tangan yang mempunyai rekabentuk penambahbaikan. Kedua-dua alatan tangan ini akan dinilai dari aspek ergonomik, kebolehgunaan, dan nilai estetika. Soalan-soalan yang berkaitan dengan ergonomik, kebolehgunaan and nilai estetika akan di buat. 50 orang responden akan dipilih untuk menjawab soalan-soalan yang telah dibuat. Keputusan yang diperolehi menunjukkan bahawa alatan tangan rekabentuk lama dinilai kurang menarik berbanding alatan tangan yang mempunyai rekabentuk penambahbaikan. Tambahan pula, alatan tangan yang mempunyai rekabentuk penambahbaikan menepati aspek ergonomik, dan kebolehgunaan.

ABSTRACT

This project is about evaluating hand tools for the purpose of an object handling task. The purpose for this project is to evaluate hand tools that are usually use for handling hot objects. There were two types of hand tool evaluated, the tong (old design) and the proposed design. Those tools were evaluated in terms of ergonomics, usability, and aesthetics. A questionnaire was developed consisting of question related to ergonomics, usability and aesthetics. 50 respondents consisting of representative users of the tools were sampled. The result indicated that the tong (old design) was rated less visually appealing than the new proposed design. In addition, the new design was perceived to be better in terms of ergonomics and in terms of usability as well.

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LIST OF ABBREVIATIONS

LPD	-	Locally Perceived Disorder
MSD	-	Musculoskeletal Disorder
SEMG	-	Surface Electromyography
MVC	-	Maximal Voluntary Contraction
EMG	-	Electromyography

CHAPTER 1

INTRODUCTION

The main purpose to producing this paper is to investigate the usage of hand tools assessment that will affect the worker or consumer from ergonomics aspects. The hand tool assessment that is use in this project is tongs. This chapter includes the project introduction, objectives, problem statement, scope, methodology, and report structure of the project.

1.1 Project Background

We have use hand tools in a daily life. There are varieties of hand tool that have differences function and application depends on user. One type of hand tool is tong. Tong is hand tool that are use for handling task such as carry or transferred the hot object, or carry the dangerous object that cannot handle with our origin hand. During usage the tong the user maybe did not know that an accident can happen to hands involving tools, cumulative trauma disorders of hand, wrist, forearm, shoulder, and neck.

Hence, the idea for this project is to analyze the usage of tongs in different application, to identify the affect from using tong in ergonomics aspect and redesign back the tong that included ergonomics aspects.

1.2 Problem statement

Nowadays, there are many types of tong that have use in different field such as in manufacturing industries, in food and beverage industries and another else. Unfortunately, the affect from use tongs have not seen until the effect will feel when getting older. Thus, perhaps this project can help to improve the tong and its usability to user and can expose the knowledge when handling the task using this type of hand tool. Furthermore, from this project can help further study about ergonomics.

1.3 Objective project

The aim of this project is to evaluate a tong usage and redesign back in ergonomics aspect that can use by any level user with did not worry the bad effect. In order to achieve the aim, several objectives have been stated as below;

1.3.1 To perform ergonomics evaluation of the existing hand tool for handling hot objects in a furnace

1.3.2 To evaluate a proposed hand tool for handling hot objects in a furnace

1.3.3 To assess the existing and proposed hand tools for handling hot objects in terms of aesthetics

1.4 Scope of project

To make sure this project achieved the objectives, the scope of project are focused on the evaluation of the existing hand tool used for transferring objects from a furnace, as well as the evaluation of a proposed hand tool for handling hot objects. Participants in this study will come from UTeM population. Plus, this study will limited to handling task involving transfer of objects from a heated furnace and unheated furnace.

1.5 Report structure

This report consists of five chapters. The following chapters are the outline of the tong research for ergonomics aspects that are propose to redesign back.

Chapter 1 will discuss briefly the overview of this project such as project background, problem statement, objective project, scope of project and project outline.

Chapter 2 will contain the research and information about the project on several important concepts of the tong, technology and tools used in this project. Every fact and information which found through journal, conference paper, websites or book will be compare and the better information have been chosen for the project. In this chapter will include the application of tong in variety field.

Chapter 3 will explain about the details of the several specific methodologies used in this project.

Chapter 4 will includes the details about questionnaires or survey result, analysis, observation, and discussion of the tong and the ergonomic analysis software.

Chapter 5 will concludes all the successful throughout this project and the future recommendation.

1.6 Project schedule

Table 1.1: Estimate Output

14 July 2010	Learn deeply about this project / Make a discussion with lecturer, PSM briefing
21 July 2010	Discuss with PSM supervisor
28 July 2010	Start to writing chapter 1
4 August 2010	Discuss with supervisor about chapter 1
11 August 2010	First Ramadan
18 August 2010	Discuss chapter 2 with supervisor
25 August 2010	Writing chapter 2
1 September 2010	Discuss chapter 3 with supervisor
8 September 2010	Semester break
15 September 2010	Semester break
22 September 2010	Develop a plan for collecting data
29 September 2010	Start collecting data
6 October 2010	Collecting data
13 October 2010	Collecting data
20 October 2010	Collecting data and analysis data
27 October 2010	Collecting data and analysis data
3 November 2010	Revision week
10 November 2010	Final exam
17 November 2010	Final exam
24 November 2010	Final exam
5 January 2011	Start new semester
12 January 2011	Discuss with supervisor about chapter 4
19 January 2011	Completion of chapter 4
26 January 2011	Completion of chapter 4
2 February 2011	Semester break
9 February 2011	Discuss with supervisor about chapter 5
16 February 2011	Completion of chapter 5
23 February 2011	Completion of chapter 5
2 March 2011	Completion of chapter 5

9 March 2011	Check all the chapter and make correction
16 March 2011	Discuss with supervisor
23 March 2011	Discuss with supervisor
30 March 2011	Discuss with supervisor
6 April 2011	Discuss with supervisor
13 April 2011	Finalize the project
20 April 2011	Revision week
27 April 2011	Final exam
4 May 2011	Final exam
11 May 2011	Final exam

CHAPTER 2

LITERATURE REVIEW

This chapter discussed background research related to this project. The purposed of background research was to gain theory or idea that can be implemented in this project. Basically, this chapter is divided into four sections which are about repetitive motion injuries of the upper limbs, hand tool ergonomics, task related to hand tool and evaluation of hand tool.

2.1 Repetitive Motion Injuries of the upper limbs

A repetitive motion injury of the upper limbs is an injury of the musculoskeletal and nervous system that may be caused by repetitive tasks, forceful exertions, vibrations, mechanical compression, or sustained or awkward positions. Furthermore, repetitive motion injury is the general word that is used to describe the prolonged pain experienced in shoulder or hands or neck or arms. It is the common word used for referring the types of soft tissue injuries such as nerve spasm, trigger finger, and carpal tunnel syndrome. It also covers others disorders such as upper limb disorders, work related upper limb disorder, musculoskeletal disorder, and cumulative trauma disorders.

The term Repetitive Motion Injuries is generally used to described the overused syndrome associated with particular repetitive activity. They are generally caused by the work associated activities such as using keyboard and mouse. The term includes a group of disorders that most commonly develop in workers using excessive and repetitive motions of the head and neck extremity.

Repetitive motion injury occurs when the movable parts of limbs are injured. Repetitive motion injury usually caused due to repetitive tasks, incorrect postures, stress and bad ergonomics. Repetitive motion injury generally caused numbness, tingling, weakness, stiffing, and swelling and even nerve damage. The chief complaint is the constant pain in the upper limbs, neck, shoulder, and back.

The main cause of this main are the repetitive activities, forceful activities of arms and hand and awkward postures. The other causes of Repetitive Motion Injuries are sitting in a fixed postures and poor workplace ergonomics. The Repetitive Motion Injuries generally affect the group of workers that are usually use excessive and repetitive motion of the neck and head in high risk conditions such as people who work in front of computer few hours a day, and people who work in production line.

The repetitive motion injury is not a life threaten injury for it can cause pain and disability. The repetitive motion injury is the worse as it may lead to permanent incapacity. As repetitive motion injury recovery is being slow process, it is better to take treatment at early stage itself.

In the other hand, repetitive motion injuries have their own symptoms. There are;

i) The user experience constant pain in the hand, elbows, shoulders, neck, and the back. Other symptoms of Repetitive motion injury are cramps, tingling, and numbness in the hands.
ii) May produce painful symptoms in the upper limbs, but the site may be difficult to locate.

2.2 Hand tool ergonomics

There are strong relationship between hand tools and the occurrence of upper extremity trauma and excessive use of poorly designed hand tools. The needs for developing clear and concise ergonomic guidelines for designing and using hand tools are also obvious. The intended users of such guidelines are tool designers and manufacturer, buyers and users and occupational health and safety experts.

Even though the basic ergonomics principles of hand tool design have been known for long years ago but does not any attention and not have initiatives to these principles in design the industrial equipments. There are many reasons for lack of success in applying ergonomic principles to hand tool design:

a) User guidelines have been general, lacking specificity, and frequently conflicting.
b) Manufacturer generally do not perceive ergonomics an important consideration in hand tool design
c) Some guidelines may be unrealistic and have undergone insufficient practical evaluation
d) A wide information gap frequently exists between the management, designer, manager, and ergonomists that do not permit implementation of scientifically developed design principles.

Many of these limitations at least in part, are continually being overcome. Particularly, in the recent years, the following have helped:

a) Researchers to fill existing gaps in knowledge
b) Increased awareness, on part of the managements, of direct and indirect costs of occupational injuries and illnesses
c) Increase emphasis on through testing of new designs
d) Availability of new material and production methods
e) Increased willingness on the part of ergonomists to use a team approach for tools and workstations design and work reorganization.

The factors associated with trauma are;

a) *Acute trauma;*

   Fingers, hands or arms caught, cut or burnt by tools

b) *Subacute / chronic trauma;*

   High forces, extreme postures of fingers, wrist and shoulders, repetitive movements, high localized pressure, segmental vibration

For all subacute / chronic trauma exposure factors, the duration of exposure is of crucial importance. Corresponding to these exposure factors are the following hand tool and task design features and hand tool user considerations;

- design of grip
- weight
- design of trigger
- special purpose
- human versus external power
- vibration characteristics
- duration and frequency of use gloves
- hand tool user considerations

2.2.1 Design of grip

The dexterity of the hand permits various kinds of grips. The two most basic grips have been defined by Napier (1956) as the power grip and precision grip. In a power grip, tool axis is perpendicular to the forearm axis and the hand makes a fist with four fingers on one side and the thumb on the other side. This grip is used when large forces are to be exerted. Depending upon the direction of the line of force, three subcategories of the power grip are defined;

a) Force parallel to the forearm such as saw
b) Force at an angle to the forearm such as hammer
c) Torque about the forearm such as corkscrew

In the precision grip, the tool is pinched between the thumb and fingers. This grip is primarily used for precision work which requires control rather than exertion of large forces. The precision grip is classified into two categories;

a) Internal precision grip
   The shaft of the tool is internal to the hand such as knife
b) External precision grip
   The shaft of the tool is external to the hand such as pencil

There are some situations that require a combination of precision and power grip. In industrial work, such combination grips are not recommended because the use of control muscles, which are smaller, to produce power can accelerate fatigue (Greenberg and Chaffin, 1977). In addition hook grip is also sometimes defined. This grip is used in situations when loads are held by the fingers and the fingers form a hook for example holding a suitcase. This type of grip should be avoided if the hand is to be used for precision tasks in the immediate future.

2.2.1.1 Precision / power

Precision grips, on the average, provide only 20% strength of a power grip (Swanson et al., 1970). As stated above, it showed that a precision grip involves small muscles but power grip involves larger muscles groups. Tools designed primarily for exertion of force, such as hammer, should use a power grip meanwhile tools designed for manipulation, such as a surgical knife, and should use a precision grip.

2.2.1.2 Angles of the forearm, grip and tool

Wrist twist can lead to various illnesses that can loss in productivity and grip strength. To avoid chronic illnesses and loss in productivity, the wrist should be kept straight (handshake orientation). If any bending is required, the tool, rather than the wrist should be bent

(Tichauer and Gage, 1977). By bending the handles and increasing the length of the upper handles, it is possible to keep the wrist straight and avoid nerve, tissue, and blood vessel compression. When large forces are exerted on the handle(s) of a straight tool, the wrist is deviated in the direction of the ulna. This causes reduced strength and endurance and leads to fatigue. In addition, the carpal tunnel is probably compressed and there is a risk of carpal tunnel syndrome. To overcome this situation, when hand / arm on the workpiece through a hand tool, the large forces should be parallel to the long axis of forearm. The tool handle axis should be set until 80 ˚ from the long axis of the tool meanwhile the large force can transfer on a workpiece.

2.2.1.3 Grip thickness

A large range of grip thicknesses has been recommended in the published literature. For precision grips these recommendations are slightly contradictory. While (Hunt,1934) prescribed an 8 mm screwdriver handle diameter rather than a 16 mm diameter because of slower work with the thicker handle, Kao (1976) recommended 13mm diameter for pens. However, Sperling (1986) observed less fatigue, lower recorded strain and larger maximal force exertions with a pen diameter of 30mm, compared to 10mm diameter. For power grips, the recommended diameters are influenced by the hand size (Greenberg and Chaffin, 1977; Kilbom et al., 1991). According to a Swedish expert group (Jonsson et al., 1977), power grips around a cylindrical object should surround more than half the circumference of the cylinder, but the fingers and the thumb should not meet. Up to a certain grip diameter, grip strength increases with grip diameter, but beyond a certain point the grip strength starts decreasing as the grip diameter increases. The optimum grip diameter is 65 mm according to Hertzberg (1973), and 51 mm according to Ayoub and LoPresti (1971). Greenberg and Chaffin (1977) observed an optimum between 50-85 mm and recommended 50mm. Fransson and Winkel (1991), on the other hand, recorded maximum grip force between 50 and 60 mm diameter for females and between 55 and 65 mm for males.

Several additional recommendations for optimum grip diameter have also been published, but in the most cases the recommended grip diameter falls between 50 and 60 mm. For practical purposes, it is important to keep in mind that people with small hands should not have to perform repetitively with power grips that have grip diameter larger than 60 mm. This recommendation is further reinforced by a positive relationship between hand size and grip strength. In cross action tools, where the shafts / grips of the tool move such as plate shear, scissors, and the maximum span should be 100mm and the minimum should be 50 mm (Greenberg and Chaffin, 1977).

Since the muscles closing the hand are stronger than the muscles opening the hand (Radonjic and Long, 1971), a spring should be used to open the handles (Kilbom et., 1991). The spring will relieve the extensor muscles during the opening of the tool.

2.2.1.4 Grip length

Hand width ranges from approximately 79 mm for a 1st percentile female (Garrett, 1969a; 1971) to approximately 99 mm for a 99th percentile male (Garrett, 1969b; 1971). Using these dimensions as the basis, Konz (1990) recommended a minimum grip length of 100 mm; 125 mm grip length is more comfortable. The Eastman Kodak Company (1983) recommended a grip length of 120 mm. Lindstrom (1973), on the other hand, recommended a handle length of 110 mm for men and 100 mm for women. In reality, it is impractical to provide different handle length tools for the same work done by males and females. In general, the grip length should be such that it would not limit the tool head opening and at the same time avoid excessive compressive forces or pressure concentration on the tender parts of the palm.