A STUDY ON HAND PRESS GRIP FORCE FOR PUSH ACTIVITY IN LAY UP PROCESS AT AEROSPACE INDUSTRY

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

by

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ABSTRACT

Grip strength is the force applied by the hand to push objects and is a specific part of hand strength. It is generally considered that all aspects of the hand must be exercised to produce a healthy and strong hand. Repetitive usage of hands will cause an imbalance between closing and opening (antagonist) muscles, and can lead to problems such as carpal tunnel syndrome. The purpose of this study is to analyse the hand press grip force and muscle fatigue at the left and right triceps for push activity among the workers in the aerospace industry while workers perform their task. By using observation, interview, questionnaires, Tekscan system and Electromyography (EMG) tools is used to evaluate hand pressure grip force and muscle fatigue of the workers. Findings will show the factors that affect the hand pressure grip force and its relation with muscle fatigue. At the end of this study, the result will be discussed to achieve the objective and also propose an ergonomic improvement in the aerospace industry.

ABSTRAK

Kekuatan cengkaman adalah daya yang dikenakan oleh tangan untuk menolak objek dan bahagian tertentu menggunakan kekuatan tangan. Secara umumnya dianggap bahawa semua aspek tangan, perlu dititik beratkan dan sentiasa melakukan senaman tangan untuk mendapatkan tangan yang sihat dan kuat. Penggunaan tangan secara berulang-ulang dalam jangka masa yang panjang akan menyebabkan ketidakseimbangan antara penutupan dan pembukaan (antagonis) otot, dan boleh membawa kepada masalah seperti sindrom carpal tunnel. Tujuan kajian ini adalah untuk menganalisis kekuatan cengkaman tangan dan keletihan otot triceps di kiri dan kanan untuk aktiviti tolakan di kalangan pekerja dalam industri aeroangkasa ketika pekerja melaksanakan tugas mereka. Dengan menggunakan pemerhatian, temubual, soal selidik, sistem Tekscan dan Electromyography (EMG) digunakan untuk menilai tekanan tangan daya cengkaman dan keletihan otot para pekerja. Penemuan menunjukkan faktor-faktor yang memberi kesan kepada daya cengkaman tekanan tangan dan kaitannya dengan keletihan otot. Pada akhir kajian ini, keputusan akan dibincangkan bagi mencapai objektif dan juga mencadangkan peningkatan ergonomik dalam industri aeroangkasa.

DEDICATION

This thesis is dedicated to my beloved parents, (Hj Zulkeflle Bin Mohamed Noor and Hjh Rozani Binti Yajid), family, friends and my loved ones who have given their support, encouragement and good advice to me. This thesis is also in debt to Dr. Seri Rahayu Kamat, a mentor who has been a constant source of knowledge and inspiration.

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CHAPTER 1

INTRODUCTION

1.1 Background

Manual material handling such as lifting heavy products, reaching materials, pushing or pulling excessive loads and bending forward their back when doing tasks because those tasks require a large degree of freedom and stable position. Pushing and pulling activities are one of the activities for manual material handling that can increase the risks of back pain problem (Kuijer et al., 2007). The pushing and pulling activities are a continuous activity for a large segment of the workforce, including hospital workers, manufacturing workers, construction workers, forest workers, etc (Jellad et al., 2013). Moreover, both of these activities are associated with the awkward posture.

The theory of the awkward posture can be understand as a discomfort posture because it is harmful position for human body when a joint is not in its neutral range of postures and cause muscles are either less or more than resting length. The muscles around the joint are stretched or compressed when joints are exposed to postures that involve range of movement near the extreme position. If the exposure to extreme postures is prolonged, the muscles do not immediately revert to their resting length (Hayot et al., 2012).

In manufacturing workplaces, most of the processes jobs were recommended to be performed in awkward posture. For example, they need to raise their elbow above their shoulder, bend their neck forward greater than 30 degrees, bend their wrist downward with palm facing downward greater than 30 degrees, bend their back forward greater than 45 degrees, and squatting, etc (T-Krajewski et al., 2009).

Musculoskeletal disorders can be caused by repetitive usage of hand-held tools due to factors such as awkward hand posture (Bovenzi et al., 1998); static loading of the muscle during repetitive gripping of the handle (Grant et al., 1993); excessive force exertions (Lin et al., 2006); the weight of the tool being supported exposure to hand-arm vibration (Lin et al., 2007) and etc. To determine the optimal diameter for handle use for the general population an extensive research has been conducted. Tool handle diameter has been identified as the most significant factors that affect grip force production (Edgren et al., 2004). Grip production, local contact pressure of a handle configuration and the perceived acceptability can be affected by factors such as handle orientation; texture, angle and shape (Sancho-Bru et al., 2003).

The Ergonomics Design and Analysis tool of Computer-Aided Three-Dimensional Interactive Application (CATIA) software and tekscan software are one of the ergonomics analysis tool that have been applied to analyse pushing and pulling activities of workers while performing tasks in awkward posture (Vieira & Kumar 2007, Landau et al., 2008, Sheikhzadeh et al., 2009, Daraiseh et al., 2010, Govindu et al., 2012).

Besides that, this ergonomics analysis tool also can quantify comfort level of working posture while workers perform their tasks using Rapid Upper Limb Assessment (RULA) feature. Several epidemiology studies used this feature because they wanted to know whether the working posture in comfort or discomfort condition (Hoy et al., 2005, Shuval & Donchin et al., 2005, Jones & Kumar 2007, Hwang et al., 2010, Ozturk & Esin 2011, Dockrell et al., 2012, Meksawi et al., 2012).

1.2 Problem Statement

In aerospace industry, almost all the jobs are performed in standing position and this can lead to muscle fatigue. At XYZ Sdn Bhd, the operators at the Layup Station are doing their task manually. Most of the task involved performing the job tasks such as pushing and pulling activity, the operators might feel the discomfort and pain in their arms and wrist. The operators are tending to experienced fatigue while performing the job at Layup Station that may take to serious injuries known as Musculoskeletal Disorders (MSDs). (MSDs) are often caused by awkward postures, excessive force and repetition because of the limited work area, standing for prolonged periods and heavy equipment. The top management of XYZ Sdn Bhd is worried about the declined health quality of the operators can affect their productivity and hence decreases the efficiency of the manufacturing operation.

This study focus on analysing the activity related with push activity that gives discomfort for workers in layup room by using Tekscan system, electromyography (EMG) and lastly giving suggestion on proper technique to reduce hand discomfort and muscle fatigue by using an ergonomic approach to overcome all the problems. Based on the scenario of the working environment at XYZ company, it is important to explain and give a better understanding about the (MSDs) and Carpal Tunnel Syndrome (CTS) in the aerospace industry.

According to the previous research done by Seri Rahayu et al., (2014) most of the problem related to (MSD) in Lay up department is related with push activities. Workers have discomfort experience with Carpal Tunnel Syndrome while undertake the activities. The result show the muscle fatigue when the workers used the sustained force in a long period of time. Due to muscle fatigue, the muscles will involve with contraction and this condition lead to discomfort. Therefore in this research we want to investigate the hand press grip force and muscle fatigue at the left and right triceps while worker undertaken push activity to show the significant effect of the Carpal Tunnel Syndrome problem in layup process/department.

1.3 Objectives

The objectives of the study are:

i. To investigate and analyse the activity related to push activities that cause discomfort to workers at Layup department in Aerospace Industry.
ii. To analyse the hand press grip force and muscle fatigue at the left and right triceps for push activity among the workers in aerospace industry while workers perform their task.
iii. To give a suggestion on proper technique to reduce hand discomfort and muscle fatigue using an ergonomic approach for the operators in aerospace industry.

1.4 Scope and Limitation of Study

This study focused on analysis of hand press grip force for push activities at Lay up department and only covered the upper limb of the body area. This study is done by collecting data from Layup department. In this study, the aspects that will be look are ergonomic requirement, ergonomic principle and ergonomic problem faced by the workers. Besides, other aspects such as improving the muscle fatigue were also covered in this study.

1.5 Importance of the Study

This study is able to:

i. Provide and analyse of the best ergonomic approach that can be used to reduce all the pain or health experience that occur because of the effects of discomfort.
ii. Encourage the implementation of ergonomics approach in aerospace industry.

CHAPTER 2

LITERATURE REVIEW

This chapter contain the literature review of the study which related to the objectives and scope of the study. It will look into Ergonomics, Ergonomic Risk Factor (ERF) and discusses the hand pressure grip force, muscle fatigue experience and push and pull activities. It also covers the Musculoskeletal Disorders (MSDs) and Carpal Tunnel Syndrome (CTS).

2.1 Introduction

Ergonomics is the science of fitting workplace condition and employments interests to the capabilities of the working population. In other meaning, ergonomic is the laws of work that define the limits to human capability. Effective and successful 'fits' assure high productivity, increased satisfaction among the employee of the organization and avoidance of illness and injury risk. Despite the fact that the scope of ergonomics is much wider, the term here refers to assessing those work related factors that may induce a risk of musculoskeletal disorder and recommendation to reduce them. Basic examples of ergonomics risk factor are found in the works involving the repetitive, forceful, or prolonged exertions of the hands; prolong awkward postures; and frequent or heavy lifting, pushing, pulling, or carrying of heavy objects. Jobs or working conditions that shows multiple risk factors will have

a higher probability of developing a work related musculoskeletal disorder. The level of risk relies on the frequency, intensity and duration of the exposure to these conditions and the individual's capacity to meet the force of job demands that might be included. (Mat Rebi, 2003).

Ergonomic assessments are required with a specific end goal in order to know how efficiently the company is implementing ergonomics or precisely where to begin when first utilizing ergonomics. An ergonomic assessment of workplace can disclose any unsafe areas, identify ergonomics solutions and help to implement an ergonomic plan that will improve the overall ergonomics of the organization.

2.2 Ergonomics Risk Factors

Ergonomics Risk Factors cause difficulties in elimination, identification, reduction and control, thus give the challenge to the management team to handle the problems. According to Mat Rebi (2003), Ergonomics Risk Factors (ERF) is a circumstances that exist or created purposefully or unintentionally that could or may help contribute to results contravene or against the standards or philosophy of ergonomics that could or may be unsafe to the wellbeing and health of clients or individuals at work or after work. Before solutions for the issues could be found, awareness and understanding on the negative factors of Ergonomic Risk Factors are essential and critical for countermeasure to take.

According to N.Jaffar et al., (2011), the primary Ergonomic Risk Factor are force, vibration, static loading, awkward posture, contact stress, repetition and extreme temperature.

2.2.1 Awkward Posture

Awkward posture occurs when any joint of your body twists or bends excessively, outside a comfortable range of movement. On the other hand, awkward posture is related to an increased risk of injury. It is generally considered that the more a joint deviates from the natural position, the greater the risk of injury.

Posture refers to the position of different parts of your body. Muscles, ligaments and tendons must work harder and can be focused on when you are in an awkward posture. If the position is held long enough for you to feel throbbing painfulness, then your muscles have been held in one position for a long time. A posture held for a long time is known as a static posture.

Posture issues can be created by work routines (bending the wrist to assemble a part; turning and twisting to pick up a box) or workplace measurements (stooping in the stockpiling of a plane on account of the limited space while taking care of baggage; extended range to obtain apart from a bin at a high position). Particular postures have been identify with injury for example, shoulder, wrist, low back and neck. Other parts of body are tenses not due to work but maintaining posture. (N.Jaffar et al., 2011)

2.2.2 Force

Force is the physical or mechanical work to accomplish particular movement or effort. Force can be defined as the measure of physical effort needed to perform certain work. Case in point lifting or to keep up control of the tools or machine. The energy may originate from lifting, grasping, pulling or pushing exercises according to N.Jaffar et al., (2011). The measure of energy relies on upon the sort of action, weight of an item, type of grasp, body position and the period of the errand. The

measure of strength needed by a movement can now be amplified bringing on significantly more muscular fatigue. It may as well contribute to musculoskeletal problems when there is insufficient time for relaxation or recovery. In general, higher force means a higher degree of risk.

2.2.3 Repetition

N.Jaffar et al., (2011) said that repetition can be simply known as performing the same movements or group of movements excessively. Repetition includes doing a work that uses the same muscles again and again with minimal opportunity to rest or recovery. Repeated identical or similar motions performed over a period of time could cause over-extension and overuse of certain muscle groups, which could lead to muscle fatigue. As a conclusion, the greater the number of repetitions, the greater the degree of risk. Still, the relationship between degree of injury risk and repetition is altered by other risk factors such as posture, force, recovery time and duration.

2.2.4 Vibration

Vibration may be characterized as any movement which a body makes about a settled point. Vibration has been discovered to be an etiological variable in workplaces using instruments vibrating in the frequency of 20 to 80 Hz. Vibration could cause damage of the body organs as an outcome of their being buffeted by high vibration levels at generally low frequencies and breakdown of body tissues because of continuous resonance wave or to their assimilation of high power vibration (N.Jaffar et al., 2011).