UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN IMPROVEMENT ON TRIMMING WORKSTATION FOR AEROSPACE COMPANY BASED ON ERGONOMICS ANALYSIS (CASE STUDY AT CTRM AC SDN BHD)

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

by

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APPROVAL

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ABSTRACT

The application of ergonomic principle is highly essential in the development of workplace to protect workers health and safety. The development and awareness on safety and comfortability brings worker quality performance. This study was performed at CTRM AC Sdn. Bhd. CTRM AC is located at Malacca which is one of the aircraft manufacturer based on the composite part. This study is focusing on the trimming process, which one of main activities that invovled in manufacturing A320 Movable Fairing panel. Trimming process required a jig to trim onto shape in order to meet customer requirement quality. Trimming of composites material has becomes one of the most hazardous processes that affect human health. From the ergonomic side, the lack of adapting the ergonomic principles would impair performance of workers. In this research, ergonomic principle is introduce as fundamentals in redesigning trimming workstation.The workstation is redesign based on anthropometry data. The data collect through the questionnaire, observation and an informal interview with the workers. Futhermore, RULA Analysis performed by using CATIA V5 software. As a result, the new propose design of trimming workstation was developed.

ABSTRAK

Penerapan prinsip ergonomi sangat penting dalam pembangunan tempat kerja untuk melindungi kesihatan pekerja dan keselamatan. Pembangunan dan kesedaran tentang keselamatan dan keselesaan pekerja memberi impak terhadap prestasi pekerja. Penelitian ini dilakukan di AC CTRM Sdn. Bhd CTRM AC terletak di Melaka, merupakan salah satu pengeluar komponen dalam kapal terbang yang berdasarkan komposit. Kajian ini memeberi fokus kepada proses pemangkasan (*Trimming*), yang merupakan salah satu kegiatan utama yang terlibat di dalam proses pembuatan panel A320 Movable Fairing. Bagi menjaga kauliti produk, proses *trimming* memerlukan bantuan jig untuk memotong panel tersebut ke bentuk yang ditetapkan oleh pelanggan (*customer*). Walau bagaimana pun, proses ini telah menjadi salah satu proses yang berbahaya yang boleh mempengaruhi kesihatan manusia. Dari segi ergonomik, kurangnya mengadaptasi prinsip-prinsip ergonomik akan menjatuhkan prestasi pekerja. Dalam kajian ini, prinsip ergonomik di perkenalkan sebagai dasar dalam mereka semula tempat kerja bagi proses *trimming*. Data antropometri digunakan untuk mereka benruk semula tempat kerja bagi proses *trimming*. Kaedah pengumpulan data dilakukan melalui questionnaire, pemerhatian dan juga wawancara kurang formal antara para pekerja. Seterusnya, RULA Analisis dilakukan dengan menggunakan software CATIA V5. Justeru itu, reka bentuk tempat kerja untuk proses trimming telah diperbaharui dan dibangunkan.

DEDICATION

Special dedication to my beloved father Abd Halim bin Abd Majid and my mom Asiah Binti Buang who are very concern, understanding, patient and supporting.

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CATIA V5	– Computer Aided Three-dimensional Interactive Application V5
CTD	– Cummulative Trauma Disorder
CTRM	– Composite Technology Research Malaysia
CTRM AC	– CTRM Aero Composite (CTRM subsidiary unit)
EDA	– Ergonomic Design and Analysis
IEA	– International Ergonomic Association
MSD	- Musculoskeletal Disorders
OOS	– Occupational Overuse Syndrome
OS	– Overuse Strain
OSHA	– Occupational Safety & Health Administration
RSI	– Repetitive Strain Injury
RULA	– Rapid Upper Limb Assesment

CHAPTER 1

INTRODUCTION

1.1 Background

Ergonomic improvements in the workplace is important in all industries all over the world. As the means of "fitting work to people", ergonomic improvement is increasingly applied in different sectors with the aim of securing safety and health at work. This is because the position and sometimes the bad design of workstation often affect workers health and safety.

According to Economy-Watch (2009), reported in 2003, workers injured while on duty in the aircraft manufacturing industry accounted for 4.7%. Meanwhile, in the private sector, sickness or injuries connected to work accounted for 5% of all accidents and mishaps related to aircraft industry. In these cases, the breakdowns in interaction between human and the machine/system used can harm workers and also may jeopardized companies performance. Costly mistakes occur in manufacturing, production and quality assurance are usually attributed in some way to human error. As a result, time and product are wasted, leaving production targets unachieved, late stock delivery, expensive down time and dissatisfied staff. The cumulative effects of which will place a heavy burden on the bottom line reducing the profit margin considerably.

Although automatic techniques have been employed in manufacturing industries to increase productivity and efficiency, there still a lots of manual handling jobs especially for assembly and maintenance jobs. In these jobs, the musculoskeletal disorders (MSDs) are one of the major health problems due to the overload and cumulative physical fatigue.

One of the major industrial disease is Cumulative Trauma Disorder (CTD), affecting millions of people around the world. CTD includes conditions such as carpel tunnel syndrome, tenosynovitis and tendinitis - often collectively referred to as upper limb disorders, musculoskeletal disorders, occupational overuse syndrome (OOS), or repetitive strain injury (RSI). There are over 30 epidemiologic studies which have examined workplace factors and their relationship to CTD. These studies generally compared workers in jobs with higher levels of exposure to workers with lower levels of exposure, following observation or measurement of job characteristics.

Ergonomic or human factors involves in the study of factors and development of tools that facilitate the achievement of human satisfaction, such as RULA (Rapid Upper Limb Assessment). C.D. Wickens et al, 2004, defines the goals of human factors are; enhances performance, increase user safety and satisfaction. Ergonomics is the application of scientific information concerning humans to the design of objects, systems and environment for human use. Ergonomics comes into every aspect which involves people. Work systems, sports and leisure, health and safety should all embody ergonomics principles (The Ergonomics Society, 2006). An ergonomic tools considered all over aspects of human such as anatomy, physiology, psychology and also the design to aims the goal. The working environment for the workers hence must be compatible with the abilities of human body and minds and also must meet needs of the manufacturing process.

1.2 Problem Statement

CTRM AC Sdn. Bhd. is manufacturing a composite part for aircraft industries. In order to achieve customer satisfaction, the composite part must fulfil the customer requirement as stated in Purchase Order. Trimming is one of the important processes for achieving customer requirement. Trimming process is a process to trim a product follows drawing requirement.

From the current design of trimming workstation, workers experienced MSD's for a quite long time. Trimming work place is highly hazardous because of the layout and the shape of fixture is not compatible with the workers. The difference between the anthropometric data for each worker contributed the various illnesses that lead to unsatisfying result.

1.3 Objective

1. To identify problems faced by workers at trimming workstation
2. To analyze the current limitation and weakness at trimming workstation.
3. To study on an ergonomic workstation.
4. To redesign workplace at trimming workstation based on ergonomic principles.

1.4 Scope

This study performs at CTRM AC Sdn. Bhd. and focusing on the improvement at trimming workstation by applying ergonomics stretch on the current workstation design. However, special focus is given to A320 Moveable fairing fixtures. The improvement will start by identifying the problem faces by workers while perform their job and then identifying the limitation on the current workplace design before precede to the design improvement on the current workstation. The ergonomics and safety analysis (such as RULA analysis) will perform to generate the result from the design and data taken. The analysis will results the differences between current designs and the propose design. Based on the result, the comparison can be made whether the propose design can be implement into the existing trimming workplace. If the propose design can improve workers satisfaction better while reduce the number of non-conformance part, the design improvement then will be apply at trimming workplace.

CHAPTER 2

LITERATURE REVIEW

This chapter describes about general design of workplace commonly used in industry in order to have a comfortable workspace. This chapter also includes the summary of several study on the factor contributed Cummulative Trauma Disorder (CTD) in industrial worker. Many things need to be consider in designing workstation before being use by human. Based on the previous researches that have been done, some examples of the research can be taken as guidance and reference according to make a design improvement for the trimming workstation.

2.1 What Is A Workplace?

The workplace is defined as "the physical area where a person performs tasks". (D. A. Attwood, et.al, 2004). The workplace may include physical fixtures such as furniture, equipment, hallways, stairs, vehicles, and displays and is affected by environmental variables such as lighting, temperature, and noise. A workstation is defined as "a location where the operator may spend only a portion of the working shift" (D.A. Attwood et.al, 2004). Workstation is subset of the workplace. An operator may travel between and work at several different workstations in the workplace.

Workplace analyse often identify problems of awkward postures, excessive lifting, twisting, etc. many of this problems often can be solved by simple ergonomic solution, such as raising the table height of assembly, properly layout space and adjusting a work workers, providing a simple jig to hold a component in the proper position (H.W Hedrick, 2003).

The goal of human factors is to design systems that reduce human error, increase productivity, and enhance safety and comfort. Workplace design is one of the major areas in which human factors professionals can help improve the fit between humans and machines and environments. Although it describe workspace design only from the human factors perspective, these human factors concerns should be considered in the context of other critical design factors, such as : cost, aesthetics, durability, and architectural characteristic. Design is an art as well as science. There are no formulas to ensure success. But general guidelines may help remind workplace designer of some basic requirements of the workplace and prevent them from designing workplaces that are clearly non-optimal.

According to the Palmer et.al (2000) in the industrial countries, the population up to 80% will experience back pain at some stage in their life. About half of the population (15%-49%) will experience back pain during any one year (Burton, Balague et.al, 2006), the cost of healed this injury cost one-third of all workers compensation payments (C.D Wickens, 2004), hence shows that the cost estimated is higher that workers affordable and it affect 50 to 70 percent of general population due to the occupational factors and other unknown factors (C. D. Wickens, 2004)

A good workplace design is based on the biomechanical, physiological, and psychological requirements of the user (D.A. Attwood, J. M. Deeb, M. E. Danz-Reece, 2004). For the human factors practitioner, workplace design is often a balancing act – balancing these requirements, when one can be offset by the other. In addition, we must consider the cost of the solution. The site must survive financially, so solutions need to be practical and cost effective.

An ergonomist Ian Chang (Hendrick, 1996) has cited to illustrated decrease in injuries and related workmen compensation expenses as measurable benefit. For example, the substitution of an ergonomically designed pistol grip poultry de-boning knife for a conventional type butcher's knife in a packaging plant reduces work-related musculoskeletal disorders and the resultant cost savings in workmen’s compensation of $100.000 per year, with the line speed also increased because of more efficient de-boning. This is a good example of how a simple, inexpensive ergonomic solution sometimes can have a high benefit pay-off.

2.1.1 Musculoskeletal Disorders and Workplace Factors

Cumulative trauma disorder (CTD) is a broad category that includes many common diseases that affect the soft tissues of the body. Since 1980’s, there has been a sharp rise report on CTD cases. Armstrong and Silverstein (1987) found that, more than 1 in 10 workers at workplace involving frequent hand and arm exertion reported CTD. In 1995, CTD News have reported that the most recent report received by the US Bureau of Labor Statistic about 302,000 CTD- related injuries and illnesses report in 1993, which up to more than 7 percent from 1992 and up to 63 percent from 1990. CTD News estimated that American employers spend more than $7.4 billion a year in workers compensation cost and untold billions on medical treatment and other cost such as litigation (C.D Wickens et.al, 2004)

Doctors use the easy concept to understand and explain what may have caused, or contributed to CTD in certain conditions. Examples of the conditions that may be caused or aggravated by cumulative trauma include carpal tunnel syndrome, tennis elbow, and low back pain.

Other terms are often used to describe the concept of CTD. These include *repetitive stress injury* (RSI), *overuse strain* (OS), and *occupational overuse syndrome* (OOS).

This document will refer to these categories generally as CTD. CTD term is commonly used in United State while Repetitive Stress Injury (RSI) is used in Europe. Eventhough the term used are different but the term emphasize that the disorders are largely due to the cumulative effects of repetitive, prolonged exposures to physical strain and stress (C. D Wickens et.al, 2004)

Among the studies that measured repetition alone, there is evidence that repetition is positively associated with CTD. The majority of studies provide evidence of a stronger positive association between repetition combined with other job risk factors and CTD.

One study (English et al. 1995) reported a statistically significant negative association between repetitive work and CTD. The specific exposure was self-reported repeated finger tapping; the investigators stated that they had difficulty interpreting this finding. All of the other statistically significant findings pointed to a positive association between repetitive work and CTD.

The work determinants of pressure in the carpal tunnel are wrist posture and load on the tendons in the carpal tunnel. Silverstein et al. (1987) showed an increasing prevalence of CTD signs and symptoms among industrial workers exposed to increasing levels of repetition and forceful exertion. This relationship was not seen when repetition alone was assessed. Similar findings on an exposure-response relationship were reported by Chiang et al. (1993), Osorio et al. (1994), Wieslander et al. (1989), and by Stock (1991) in her reanalysis of the Nathan et al. (1988) data. However, Morgenstern et al. (1991) and Baron et al. (1991) reported increased prevalence of CTD with increasing length of time working as a grocery cashier.

Stetson et al. (1993) estimated manipulation forces based on weights of tools and parts and systematically recorded observations of one or more workers on each job. Jobs were then ranked according to grip force cutoffs. Nathan et al. (1988, 1992) and Osorio et al. (1994) estimated relative levels of force (e.g., low, moderate, high) after observation of job tasks. McCormack et al.(1990) grouped jobs into broad job categories based on similarity of observed job tasks; one job group (boarding) required forceful hand/wrist exertions. Baron et al. (1991) and Punnett et al. (1985) used job title as a surrogate for exposure to forceful hand/wrist exertions.

Stetson et al. (1993) conducted nerve conduction studies on 105 administrative and professional workers, and 240 automotive workers. Hand/wrist forces were estimated based on weights of tools and parts and systematically recorded observations of one or more workers on each job. Jobs were then ranked according to grip force cutoffs: <6 lb, >6 lb, >10 lb. Median nerve measures differed among the groups: index finger sensory amplitudes were lower and distal sensory latencies were longer among automotive workers in jobs requiring grip force >6 lb and >10 lb,

In determining the effect of CTD, those studies which addressed posture of the hand/wrist area including those addressing pinch grip, ulnar deviation, wrist flexion/extension been selected. Posture is a difficult variable to examine in ergonomic epidemiologic studies. It is hypothesized that extreme or awkward postures increase the required force necessary to complete a task. Posture may increase or decrease forceful effort; its impact on MSDs may not be accurately reflected in measurement of posture alone. Reasons that the variable “extreme posture” has not been measured or analyzed in many epidemiologic studies are:

- Extreme variability of postures used in different jobs as well as the extreme variability of postures between workers performing the same job tasks.
- Several studies have taken into account the effects of posture when determining other measured variables such as force (Silverstein et al. 1987; Moore and Garg 1994); and
- Stature often has a major impact on postures assumed by individual workers during job activities.

Silverstein found no significant association between percentages of cycle time observed in extreme wrist postures or pinch grip and CTD. “CTD jobs” had slightly more ulnar deviation and pinching but these differences were not statistically significant. The authors noted that among all the postural variables recorded, the variability between individuals with similar or identical jobs was probably the greatest for wrist postural variables. This individual variation within jobs was not