UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ANALYSIS AND VALIDATION OF WORKSTATION DESIGN FOR MECHANICAL ASSEMBLY DEPARTMENT IN AERO-COMPOSITE INDUSTRY

Submitted in accordance with the requirement of the Universiti Teknikal

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by

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Sesi Pengajian: **2017/2018 Semester 2**

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I hereby, declared this report entitled "Analysis and Validation of Workstation Design for Mechanical Assembly Department in Aero-composite Industry" is the result of my own research except as cited in references.

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Date   : ……………………………………

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Bachelor Degree of Manufacturing Engineering (Hons). The member of the supervisory committee are as follow:

……………………………………….

(Ruzy Haryati Binti Hambali)

ABSTRAK

Pengetahuan ergonomik adalah penting dalam mana-mana industri. Tanpa aplikasi pengetahuan yang tepat, seseorang mudah terdedah kepada bahaya persekitaran kerja. Aktiviti yang dilakukan oleh para pekerja di kebanyakan industri semasa proses kerja terlibat dengan menggunakan tenaga yang berlebihan, pengulangan pergerakan, pendedahan kepada getaran yang berlebihan, kedudukan badan yang janggal dan statik untuk jangka waktu yang panjang. Tujuan projek ini adalah untuk menganalisis dan mengesahkan risiko ergonomik dan reka bentuk stesen kerja untuk jabatan pemasangan mekanikal dalam industri aerokomposit. Untuk berbuat demikian, beberapa kaedah digunakan untuk mencapai matlamat projek. *Nordic Musculoskeletal Questionnaire (NMQ)* digunakan untuk melihat perbandingan di bahagian belakang badan, leher, bahu dan aduan yang biasa dilaporkan untuk penggunaan pembelajaran epidemiologi di kalangan pekerja di jabatan tersebut. Reka bentuk stesen kerja sedia ada untuk jabatan ini akan direka bentuk dan disimulasikan menggunakan *CATIA V5* dan *DELMIA V5* untuk mendapatkan analisa *Rapid Upper Limb Assessment (RULA)* dan juga penggunaan tenaga. Reka bentuk stesen kerja baru akan direka berdasarkan garis panduan umum reka bentuk dan prinsip reka bentuk sejagat di mana kedua-dua aspek akan digunakan sebagai pengetahuan asas dalam membina reka bentuk stesen kerja baru. Reka bentuk stesen kerja baru akan melalui proses penilaian yang sama seperti reka bentuk stesen kerja yang sedia ada untuk memperoleh analisa *RULA* dan penggunaan tenaga. Perbincangan mengenai hasil dari kedua-dua reka bentuk stesen kerja akan dibuat untuk menunjukkan perbezaan dan peningkatan yang dilakukan untuk jabatan. Projek ini boleh menyumbang ke arah persekitaran kerja yang lebih baik yang mana akan mematuhi faktor ergonomik dan juga ke arah persekitaran yang mampan.

ABSTRACT

Ergonomics knowledge is crucial in any industries. Without proper knowledge applied, one is easily exposed towards the dangerousness of the working environment. The activities done by the workers in most of the industries during the work processes involved with exerting excessive force, repetition of movement, exposure to excessive vibration, awkward and static posture for long period of time. The aims this project is to analyse and verify the ergonomic risk and the workstation design for the mechanical assembly department in aerocomposite industries. In order to do so, several methods are used to achieve the aim of the project. Nordic Musculoskeletal Questionnaire (NMQ) is used to evaluate the level of pain that include the low back, neck, shoulder and common complaints for epidemiological learning usage among the workers in the department. The existing workstation design for the department will be designed and simulated using CATIA V5 and DELMIA V5 to obtain the computed analysis of the Rapid Upper Limb Assessment (RULA) and also energy expenditure. The new workstation design will designed based on the design general guidelines and universal design principle in which both aspects will be used as the basic knowledge in constructing the new workstation design. The new workstation design will go through the same evaluation process as the existing workstation design in order to obtain the computed analysis of RULA and energy expenditure. A discussion on the result from both workstation designs shows the conceptual workstation design does eliminate the ergonomic risk and also consumed lower energy. This project can contribute towards a better working environment in which obey the ergonomic factors and also towards a sustainable environment.

DEDICATION

I dedicate my thanks towards

my beloved parents, Abu Bakar bin Mohamed Yasin and Noraziah binti Mohd Nor

my adored siblings, Hazree Azmir, Aiman Ariff and Farah Wahidah

my trusted friends

and to all people whom dearest to me

for giving me moral support, money, cooperation, encouragement and also understandings

ACKNOWLEDGEMENT

In the name of ALLAH, the most gracious, the most merciful, with the highest praise to Allah that I manage to complete this final year project successfully without difficulty.

My respected supervisor, Ruzy Haryati Binti Hambali. Her kindness, unwavering patience and mentorship guided me through all up and down to the extent that her helps allowed me to grow and learn in such a way that I am now a better researcher. Without her guidance, I may not complete this project within the allocated time.

Lastly, I would like to thank everybody who was important and had contributed their ideas to this FYP report, as well as expressing my apology that I could not mention personally each one of you.

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NMQ -   Nordiq Musculoskeletal Questionnaire

RULA -   Rapid Upper Limb Assessment

REBA -   Rapid Entire Body Assessment

MSD -   Musculoskeletal Disorder

LIST OF EQUATIONS

cal	-	Calories
s	-	Seconds
mm	-	Millimetre
cal/s	-	Calories per second
%	-	Percent
kcal/min	-	Kilocalories per minute
lb	-	Pounds

CHAPTER 1

INTRODUCTION

This chapter provides the information regarding the background of project, problem statement, objectives of project, scope of project, significant of project and thesis outlines.

1.1 Background of project

In explaining about the workstation design, it is also regarding the ergonomics. Ergonomics can be defines as basic study of work. To be more precisely in defining the ergonomics, it is the science of designing the job to adapt the employee, rather than physically imposing the employee's body to fit the work. Optimizing all of the tasks, work stations, tools, and equipment to fit the worker can aid them by reducing physical strain on the employee's body and eradicate certain possibilities such as injuries that affect the human's movement.

As a manager or a worker in the industrial, construction, marine and agronomic manufacturing, all work activities and job conditions are mostly involve with repetition of the same gesture throughout workday, working in awkward or immobile spots, using an

extreme force to accomplish tasks, being wide-open to unnecessary vibration or lifting a heavy or awkward items. If a tool and equipment to complete the work task in the work process do not include ergonomic ethics in their design, labours may have exposure to certain issues such as too much physical stress, strain, and overexertion, including shaking, awkward positions, strong exertions, repetitive gesture, and weighty lifting.

Ergonomics knowledge is crucial in any industries (Gasova et al., 2017). Without proper knowledge applied, one is easily exposed towards the dangerousness of the working environment. Thus, the needs of learning the ergonomics should be provided by the employer. As the worker is well known about the ergonomics factor, the worker will unintentionally implement a good working posture in which creates a good working environment.

Virtual reality (VR) is a new technology that is becoming more essential towards human kind especially in the modern education. VR is commercialized towards the people as a video game in which the user need to use certain movement of their body in order to interact with the game. However, VR can give more advantages rather than being an interactive game. VR can help one to simulate the real working environment into the virtual environment thus helping them to practice or investigate any issues that occurs.

For example in dentistry sector, training using VR is constantly applied to improve hand-eye coordination in pre-clinical settings, fine motor skills, and overcome the monetary and intellectual challenges (Roy *et al.*, 2017). Thus, this show that VR is not focuses into one major industry in which it proves that VR can helps a lot of sectors that require the guidance of it.

The simulation of worker and work process in the virtual reality environment can help to detect any issues that involve with ergonomics. Ergonomics factor should be put as the top priority in any industries. Ergonomics is one of the sciences in which considers the health of the human, performance of the human during working process and activities and

movement made by human body during work (Naeini & Mosaddad, 2013). In order to detect the ergonomics issue that might occur during the working process, software called Delmia V5 is used to simulate the worker and working process involved.

Delmia V5 software has the design of a feature and device, the manufacturing process design in an integrated suite of tools, and an influential 3D imagining and virtual simulation using plant and manufacture system design (Caie, 2008). Thus, any result obtained from the software can be used to validate any issues that involve the ergonomics problem occurrence. Based on the result, an improvement can be made to achieve the best solution to eliminate the problem thus enhancing the worker efficiencies and productivities.

The problem in most of the industries occurred when their current workstation design and not aligning with the safe ergonomic factors. Thus, some of the activities involved in the work processes tend to change its behaviour in which may have ergonomic risk in it. This aspect can contribute to human performance, fatigue, and even worse Musculoskeletal Disorder (MSD). Simulation and improvement using DELMIA V5 suggested to help the elimination of the problem occurred in the industries. The software also helps cutting the cost for the improvement by validating the suggested design.

1.2   Problem statement

In most of the industries, OSHA (2000) stated that most of the activities done by the workers during the work processes involved with exerting excessive force, repetition of movement, exposure to excessive vibration, awkward and static posture for long period of time. Based on Lin *et al.* (2002) similar job description has been identified in the lower back pain patients in which they were involved with years of manual lifting of heavy weight object that need to be carried at certain distance.

Based on the NMQ and interview at the mechanical assembly department in aerocomposite industries, it is reported that the workers are involved with activities that need them to apply extreme forces. This activity is done by manual handling in which it requires few numbers of people in the department to stop their current work and aid the lifting process until all process in the station is done. This is due to the insufficient of equipment to execute the process using machine. It also proven what is stated by Hoogendoo *et al.*(1999), physical and psychosocial factors at work had adjusted by lifting, driving or whole body vibration, bending and twisting, and heavy physical work. Thus, this could give major issues and leads to pain and injuries of the workers in industry.

1.3   Objectives

In order to counter the problem statement, this project aims focus to analyse and verify the ergonomic risk and the workstation design for the mechanical assembly department in aerocomposite industries. Thus, the aim of the project can be achieved through these objectives:

(a) To investigate the ergonomics risk factor among the workers in the mechanical assembly department.

(b) To validate the ergonomic problem occurred among the workers in the mechanical assembly department using DELMIA V5.

(c) To propose a conceptual workstation design in order to eliminate the ergonomic problem occurred.

1.4　Scope

The analysis and validation of ergonomics risk and workstation design will be held at the mechanical assembly department of an aerocomposite industry. A Nordic Musculoskeletal Questionnaire will be used to obtain the data on ergonomics risk assessment and the survey will be handed over to all 35 workers in the department.

The data collected form the survey will then be analysed and used to construct the graph using Microsoft Excel. Based on data analysed on the graph and observation in the department also the RULA analysis, a new workstation design will be design in CATIA V5. The new workstation design is then being simulated and analysed using DELMIA V5.

1.5　Significance of project

There are several potential benefits that can be achieved by the company after this project is finished. By aligning the tool and equipment used in the workstation in which to complete the work process in terms of ergonomic views, an improvement can be done towards the work place. The improvement of the new workstation design that will be implied for the mechanical assembly department will surely eliminate the ergonomic problems and issues among the workers such as excessive force used, repetitive work element, awkward posture and heavy lifting.

The changes that will be done can also increase the safety and health of the workers due to its good implementation of ergonomic factors. Thus, this improvement will make the worker and the working environment in the mechanical assembly department feel

secure and safe form any possible hazard that can happen. A good working situation can also unintentionally increase the productivity of the workers.

1.6   Thesis outlines

In Chapter 1 which is the introduction of the project, this section will be discussing on the background of the project. The problems are identified through deep observations of the working processes and standard operating procedure. It is followed by objectives that need to be achieved throughout the whole project and scope in which will narrow down the area covered in the project. The important of the project to the company is also revealed.

Meanwhile, literature review will be presented in Chapter 2. The literature review will brief deeply any regards of keyword and methodology for this project based on previous published books, journals, studies, and researches. Chapter 3 will explain about the methodology used for this project. Each method used to achieve the objectives of this project will be explained thoroughly in this chapter.

Then in Chapter 4, then content will be on the data and result obtained from each method used to achieve the project's objectives that are mention in the previous chapter. Lastly, Chapter 5 will bring upon the conclusion of the project and recommendation for the project.

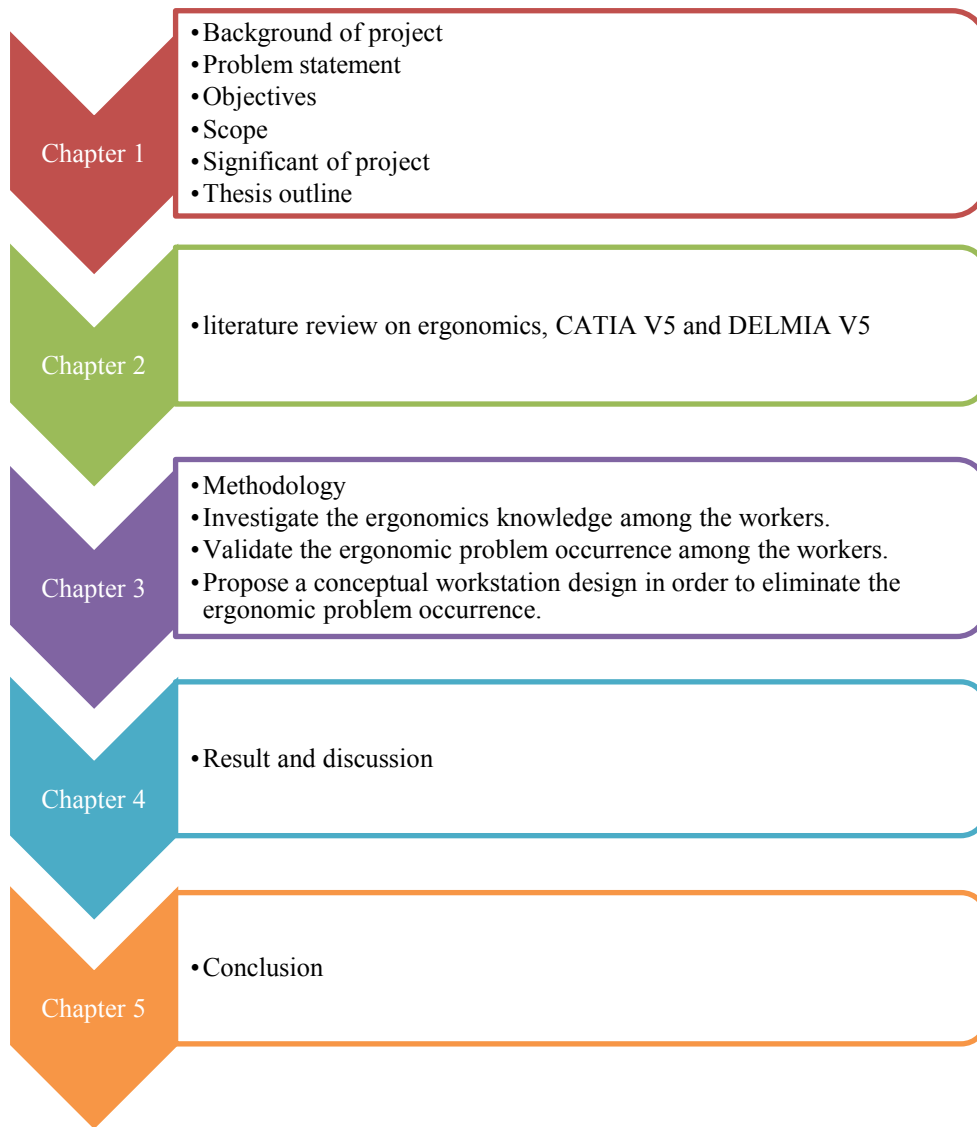| Chapter 1	• Background of project • Problem statement • Objectives • Scope • Significant of project • Thesis outline
Chapter 2	• literature review on ergonomics, CATIA V5 and DELMIA V5
Chapter 3	• Methodology • Investigate the ergonomics knowledge among the workers. • Validate the ergonomic problem occurrence among the workers. • Propose a conceptual workstation design in order to eliminate the ergonomic problem occurrence.
Chapter 4	• Result and discussion
Chapter 5	• Conclusion

Figure 1.0: Thesis outline.