
**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

# Ergonomic Workstation Design: A Study on Electric Arc Welding Operation in UTeM Workshop

Thesis submitted in accordance with the requirements of the Universiti Teknikal Malaysia Melaka for the Degree of Bachelor of Manufacturing Engineering (Design)

By

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**UNIVERSITI TEKNIKAL MALAYSIA MELAKA (UTeM)**

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I hereby, declare this thesis entitled “Ergonomic Workstation Design: A Study On Electric Arc Welding Operation In UteM Workshop” is the results of my own research except as cited in the references.

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# ABSTRACT

In the learning and teaching of practical process in electric arc welding workstation in Universiti Teknikal Malaysia Melaka (UTeM), occupational health plays an important role in maintaining and maximizing comfort and effectiveness of learning and teaching process to the students, staffs and lecturers. In order to maintain and maximize a comfort and effectiveness of learning and teaching process in electric arc welding workstation, a study to find out what are the problems and its contributors to occupational health were conducted. The study was include with gain information and response from staffs and students who using workstation, and assessing and analyzing the factors which contribute musculoskeletal disorder by using ergonomic assessment tool. Based on the results obtained from the assessments, improper workstation design was identified as the main contributor to musculoskeletal disorder factor. The ergonomic intervention is the one solution which can solve the problem. The method which uses to try to eliminate the factor is make some redesign on workstation by simulation in software, and then evaluation of improved workstation design were conducted after that. The project was carried out among the staffs and students who using the electric arc welding workstation in Faculty of Manufacturing Engineering (FME) workshop.

# DEDICATION

*For my beloved Father and Mother who always encourage and give me all the support that I really need during accomplish this thesis*.

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# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

| | | |
|---|---|---|
| CTI | - | Cumulative Trauma Injuries |
| CWCI | - | California Worker's Compensation Institute |
| FME | - | Faculty of Manufacturing Engineering |
| UTeM | - | Universiti Teknkal Kebangsaan Malaysia |
| MIG | - | Metal Inert Gas |
| MRC | - | Medical Research Council |
| MSD | - | Musculoskeletal Disorder |
| OWAS | - | Ovako Working posture Analyzing System |
| REBA | - | Rapid Entire Rapid Body Analysis |
| RMD | - | Repetitive Motion Disorder |
| RULA | - | Rapid Upper Limb Assessment |
| TIG | - | Tungsten Inert Gas |

# CHAPTER 1
# INTRODUCTION

This chapter is intended to provide comprehensive background information of this project. It tries to give an explanation about what are the project is aim to be. Descriptive information is also given on: background and problems, project requirement, project scope and limitations, potential benefit from the project, and project outline.

## 1.1 Background and Problems

Universiti Teknikal Malaysia Melaka (UTeM) was established on December 1st, 2000. It was changing its name from Kolej Universiti Teknikal Kebangsaan Malaysia (KUTKM) into the new one Universiti Teknikal Malaysia Melaka in March 1st, 2007. The UTeM was established under Section 20 of the University and University College Act 1971 (Act 30). It is a pioneer in the use of the "Practice and Application Oriented" teaching and learning method for technical education in Malaysia. This is in accordance with the government's decision to cater for the human resource need of Malaysia's industries.

UTeM is the first Public Higher Education Institute in Malaysia that emphasizes solution to industrial-based related problems. Thus, compared to other more established universities in Malaysia, UTeM as the new born university is has advantage in term of facilities for learning. That is proved by existing many, or more than enough of facilities such as labs, shops, workstations, machines, and advance machines in UTeM for the sake of learning perfection to students, and research activities by involved peoples such

as lecturers and external clients. With existing these facilities especially labs, shops, and workstations, UTeM believes that students will gain the real exposure in ready for themselves to be an engineer that not just have high knowledge in theory aspect, but rather than that they have highly competition in aspect of technical oriented application. UTeM has five faculties namely Electrical Engineering, Electronic and Computer Engineering, Mechanical Engineering, Manufacturing Engineering, and Information and Communication Technologies.

Faculty of Manufacturing Engineering (FME) is the one among of few components that established under establishment of UTeM in December 1st, 2000. In line with the aspiration of UTeM, the FME aims to produce a knowledgeable, competent and highly skilled manufacturing engineers. The academic programs that offered in FME is very technical which emphasize in practical aspect or 'hands-on', thus students were disclosed into handling tools or specific machines which used in various industries. Labs and shops had been established there is for the sake of providing academic service to degree and diploma program, running the research and development activities, and providing services to external clients from industries and government agencies. In FME, there were has an existing few workshops that provide a convenience to students and staffs, and one among of them is welding shops.

The welding shop in Phase B is the one of facilities that exists under FME superintendent. The welding shop is giving academic service to students, and they were completely taught about the welding process including safety aspect, welding tools, types of welding, positions of welding, chosen of raw materials for welding, and deformations in welding's result. In the shop, there divided into five workstations such as robotic welding, resistance welding, spot welding, gas welding (TIG and MIG), and electric arc welding. All the workstations have their own arrangement and design style. They were had been arranged and designed as well as comfortable to users when using these work station. But the question, do the arrangement or design of these workstations is able to provide a comfortable or match with a needed of ergonomic factors? Do the

current design of workstations is free from acquiring problems that related to health of welding workstation users? So, some studies and researches will implement here in order to make some improvements from the current design of workstations if needed. And the scope of study was going to electric arc welding workstation due to frequent of its usage by students and staffs. It is not mean the others welding workstations are not important to do the improvement, but the electric arc welding workstation is most in giving priority because while compared to other welding workstations, this workstation is most often used. Moreover, the others welding workstations are quite same of their appearance and function to electric arc welding workstation. So, in other hand, it can say the electric arc welding workstation is become as representative to the others in order to implement the studies.

The electric arc welding workstation under FME superintendent is organized by several technicians. The current workstation is including five booths. Each booth contains one working table, one cable, one torch, one conventional arc machine, and one inverter arc welding. There are also completed by one pedestal grinding machine, one waste scrap, one steel scrap, and one power saw. Although UTeM has more than enough the labs, workshops, and workstations, but did the facilities permanently giving certainty to the users practiced safe working posture? In the context of work station design, it plays as the one important thing which very emphasis to prevent occupational diseases for users benefit. Thus, the more good workstation design, the more good performance get achieved. The users comprise lecturers, external clients, and especially students and staffs oftenly do their works in electric arc welding workstation in prolonged period. They are work in a static, standing position for prolonged time. Example of this type of work is welding the work piece which lay on table. As these students and staffs may spend long time to do their work it is important that they are comfortable, adopt safe posture and proper working practices to ensure that the possibility of developing a musculoskeletal disorders is minimized especially if static, repetitive and strenuous tasks are being performed.

Works which practice in prolonged is should be make consider about the safety and health of worker (students, staffs, and other users). The posture adopted by the users while performing their tasks is directly determined by the dimensions and arrangement of the workstation design and equipment used, particularly in relation to distance of reach, field of view and space to move freely. When you think about how to improve a workstation, a Medical Research Council, United Kingdom (MRC 2004) recommends remembering this rule: *If it feels right, it probably is right. If it feels uncomfortable, there is probably something wrong with the design, not the worker.* This is clearly illustrated in Figure 1.1 whereby the students and staffs doing a welding work in awkward postures and static in prolonged period due to improper workstation design, and they may be exposed to musculoskeletal disorders such as lower back pain, upper back pain , shoulder, elbows, and knees pain.

Figure 1.1: Working Posture Adopted by the Students and Staffs in Faculty of Manufacturing Engineering electric arc welding workstation

Most common hazards in welding practice such as rigorous manual precision requirements, awkward and static postures, and repetition (high work intensity) are matters that always experienced by welders. These all hazards also contribute to

musculoskeletal disorder. Beside that, there are more problems which become troubles to welders in welding workstation such as fumes and gas, noise, radiation, burn, mechanical hazards, tripping and falling, and electrical hazards. There are several approaches that can be applied to eliminate or reduce the occurrence of occupational diseases in welding workstation. One among of them is engineering redesigns.

Engineering redesigns aims to control exposure of the occupational risk factors to welders. Engineering redesign controls are preferred over all other control methods because they involve designing the workstation to fit the individual and not the reverse. Examples of engineering redesign most commonly used include the design of workstation. Workstation should be easily adjustable and designed for each specific task so that they are comfortable for the welders and are appropriate for the job being performed. Specific attention shall be paid to static loading of muscles, reach requirements, force requirements, sharp or hard edges, support for the limbs, equipment orientation, and layout of the workstation. In order to redesign a workstation, the designers should be taking a consideration on anthropometric data for the users population.

Anthropometry is the study and measurement of human body dimensions. Anthropometric data are used to develop design guidelines for heights, clearances, grips, and reaches of workplaces and equipments for the purpose of accommodating the body dimensions of the potential workforce. Examples include the dimension of workstation for standing or seated work, production machinery, supermarket checkout counters, and aisles and corridors. The workforce includes men and women who are tall or short, large or small, strong or weak, as well as those who are physically handicapped or have health conditions that limit their physical capacity.

## 1.2 Problem Statements

a) Staffs and students might be experience musculoskeletal disorders due to improper workstation design.

b) Doing work in static, standing position for prolong duration can provide a trouble to the health of users.

c) During perform the welding work, sometimes staffs and students is in an awkward posture position; it is not good for their health

## 1.3 Project Requirement

In providing a better workstation to welders (staffs and students) in term of elimination or reducing occupational diseases, it is necessary to adopt engineering redesign approach. From here, the introduction of engineering redesign approach promotes the occupational health awareness among the welders in FME electric arc welding workstation. Specifically, this project requires achieving the following objectives.

### 1.3.1 Objectives

(a) To acquire information and response from staffs and students due to existing workstation.

Staffs and students are interviewed to determine the impact of existing electric arc welding workstation to their health and comfort. This effort is beneficial in order to provide detail information regarding to implication of existing electric arc welding workstation.

(b) To redesign the existing workstation based on Malaysian Industrial worker anthropometry.

Redesign the workstation give benefit to eliminate or reduce occupational musculoskeletal disorder. Safe workstation design is capable to contribute a safe working condition. The redesign most recommended follows the Malaysian Industrial worker anthropometry to give more precise workstation dimension and match with the staffs and students in UTeM. That is because in different country, there has different of industrial worker anthropometry. For example, the industrial workers in European countries are larger than industrial workers in Asian countries, in term of their anthropometric.

(c) To evaluate effectiveness of proposed redesign.

Appropriate software will be utilized to evaluate the effectiveness of proposed design in order to enhance health and comfort of students and staffs in UTeM.

## 1.4 Project Scope and Limitations

This section tries to explain the scope and limitation of carried out the project. The project specifically focuses on redesign of electric arc welding workstation in UTeM workshop. A case study was carried out among technician staffs and students (male and female) who perform the work in electrical arc welding workstation.

The project is directed to improve existing workstation design using engineering redesign associated with ergonomic participatory approach. The physiological factor such as working posture was analyzed to determine the impact of existing workstation design to staffs and students comfort. The physical quantities such as loads manipulated

by the staffs and students as well as arrangement of existing workstation design are also being taken into consideration.

The proposed design was found to be an effective solution to enhance comfort of staffs and students. Nevertheless, the implementation of proposed solution is depended on UTeM's willingness to deploy the solution. In addition, the UTeM's managements are free to make decision whether to accepted proposed design. Moreover, the project work has no direct access and authority to enforce the proposed design to UTeM even though the effectiveness of proposed design was proved.

## 1.5 Potential Benefit from The Project

The aim of the project is to provide a solution of a safe working condition in the electric arc welding workstation for the staffs and students. Hence, the ergonomics participatory approach is adopted in this project because as it been identified to offer several potential benefits which can be summarized as follows:

a) The redesign workstation due to ergonomics intervention will provide staffs and students comfort and safe working condition. It will provides them feel so satisfy while doing welding works or learning in workstation. It is hoped that by redesign the welding workstation, the performance of staffs and students will be increased.
b) The information on occupational health in welding workstation will be documented. This information will be beneficial for future research related to occupational health in welding workstation.
c) The methodology used for the project is informative to Faculty of Manufacturing Engineering (FME) because it provides a new perspective on how to improve occupational health in their working environment in workstation. It is hoped that

by adopting this ergonomics participatory approach, FME will be able to provide more effectively teaching and learning activities in their workstation.

## 1.6 Project Outline

The four-stage of project approach can be summarized as follows:

a) To gain information and response from staffs and students who using the electric arc workstation (stage one).

   Stage one is the primary importance as it attempts to address some of the highlighted statements to achieve the objectives of the project. The response is such as problems and troubles related to health of staffs and students who using the workstation. The health problem like musculoskeletal disorder is expected disease which suffered by them. To identify the probability of occureable problems, some method such as questionnaires and direct observation techniques were applied.

b) Assessing and analyzing the factors which contribute the problems and troubles by using ergonomic assessment tool (stage two).

   The working posture of workers during performing their task are measured and analyzed conscientiously so as to determine the level of risk that they experienced. Ergonomic assessment tools are utilized in order to achieve the objective.

c) To propose solution based on the result of analysis (stage three).

   This stage is about to redesign of existing workstation and selection of suitable means to counter the musculoskeletal disorder factors. Appropriate working table and the other equipments are introduced during this stage so that staffs and students can maintain with normal posture when do the welding work

d) To evaluate the proposed solution (stage four).

The CATIA Software is used to simulate the effectiveness of proposed design of electric arc welding workstation.