COMPUTER AIDED ERGONOMICS DESIGN ANALYSIS IN AUTOMOTIVE APPLICATION

NORAZAM BIN JAMEL

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Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka

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"I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and the original work contain herein have not been taken or done by unspecified sources or person"

Signature :…….

Name of Writer: Norazam Bin Jamel

Date : ……

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ABSTRACT

Ergonomics is a science of biometrics, and anthropometric that normally refers to the analyzing and designing work environment (driving) for maximizing safety and effectiveness. The design of work space must meet the ergonomics requirement to avoid the driver especially significant discomfort and pains. There is lot of tools to analyzed ergonomics such as RULA (Rapid Upper Limb Assessment), RAMSIS (Realistic Anthropological Mathematical System for Interior Comfort Simulation; German Model), 3DSSPP^{TM}, and SAMMIE CAD. The assessments have different method and step but the main purpose is to analyze the created manikins reacted to the product and environment. This research focuses on RULA method and fully assess to the driver posture that react to the dashboard. The analysis done by using software CATIA V5R10 and normally assess by RULA Employee Worksheet Assessment.

ABSTRAK

Ergonomik adalah cabang sains untuk biometrik dan antropometrik selalunya merujuk kepada penganalisisan dan merekabentuk persekitaran kerja (semasa memandu) untuk memaksimakan keselamtan dan kecekapan. Rekabentuk persekitaran kerja mestilah menepati keperluaan ergonomik untuk mengelakkan pemandu berasa tidak selesa dan sakit. Terdapat pelbagai alat atau perisian yang boleh diguanakan untuk menganalisis ergonomik seperti RULA (Rapid Upper Limb Assessment), RAMSIS (Realistic Anthropological Mathematical System for Interior Comfort Simulation; German Model), 3DSSPP^{TM}, dan SAMMIE CAD. Pendekatan dan cara penilaian adalah berbeza tetapi menpunyai matlamat (fungsi) yang sama adalah untuk menganalisis manikin yang telah dicipta untuk bertindakbalas dengan produk dan persekitaran. Kajian ini lebih memfokuskan kepada cara penilaian RULA dan sepenuhnya mengkaji postur pemandu yang berinteraksi dengan produk (dashboard). Penilaian dilakukan dengan menggunakan perisian CATIA V5R10 dan penilaian secara normal melalui Borang Penilaian Pekerja RULA.

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CHAPTER I

INTRODUCTION

1.1 Ergonomics

Ergonomics is another name for Human Factors (HF). Ergonomics normally refers to designing work environments for maximizing safety and effectiveness. Biometrics and Anthropometrics play a key role in ergonomics. Engineering Psychology often has a specialty dealing with Workplace or Occupational Ergonomics.

Nowadays lot of company thought that the ergonomics is an important thing that should be considered to improve the safety and effectiveness. Now they really need ergonomics because they have learned that designing a safe and effective product especially for the product such as cars. This can give the greatest impact can be seen for both safety and efficiency.

Generally, Ergonomics Engineer will cooperate with Design Engineer to apply an accurate and systematic technique to ensure a high factor of safety (FS) and hazard-free for the new or OEM's (Original Equipment Manufacturing) products.

1.2 Problem Statement

Today all the company that carry out the product development must be considered ergonomics as a tool to guaranteed the efficiency of the products. For this study focus on the arrangement features on the dashboard in several cars were made. The good example for this study is a Proton *Saga 1.3 Dashboard* was selected.

The study focus on the position of the button and the reachable place to create a good posture so that the driver population from five 5^{th} percentile to 95^{th} pencentile. From the recent Proton *Saga 1.3* dashboard the ergonomics design is "usual"; dulled design. There is an opinion why the tachometers must be displayed erectly, front of the driver; Why not the tachometers we displayed on sight of the view of the driver. The placement of each part can make a different in human posture and of road-washing vehicles, which drive with the neck and trunk flexed, bent and twisted. Results showed a significant connection between trunk and neck scores and all self-reported pains, aches or discomforts in the trunk or neck regions in all subjects. In particular, the neck score was significant in both postures, reflecting high loading of the neck. Significantly different posture scores were also recorded for drivers that always drive with the neck and trunk flexed, bent and twisted versus the driver in relaxation posture while long distance driving.

From this problem statement, this research objective is to achieve the good ergonomics design based on the several methods that should be considered and will be discuss more on the literature review. The method based on the movement on the anthropometrics analysis and use of Rapid Upper Limb Assessment known as a RULA method for the evaluation of the exposure to risk factors associated with work-related upper-limb disorders.

1.3 Research Objective

The objectives of the research are:-

i. To study on the Human posture, Anthropometrics, and biometrics which used a several method such as RULA (Rapid Upper Limb Assessment).
ii. To study the interior design for button placement, display placement, and the suitable posture to the button or view-reach for the tachometer.
iii. To determine how people respond to technological stimuli. The brand new of design.
iv. To aid in the development of human–machine system.
v. As a tool to predict the human performance as a function of equipment-system characteristics.

1.4 Research Scope

i. Research focused on the Ergonomics Design for automotives application by using CATIA V5R10.
ii. Research based on the current design currently used in automotive application that is Proton *Saga 1.3* Dashboard.
iii. Analysis the manikins' reaction and manipulate at an original design of *Saga 1.3* Dashboard based on the RULA (Rapid Upper Limb Assessment) both left and right.
iv. Proposed a new design for *Saga 1.3* Dashboard that according to the analyses that have done to the manikins.

1.5 Importance of Research

Some of the essential parts of the research are listed below:

i. Determined the current design of the dashboard especially Proton *Saga 1.3* still reliable for the driver.
ii. The critical point of ergonomics at human body determined.
iii. Position of the button and gear knob at specific place determined by scientific analysis; Based on RULA assessment.
iv. New idea for dashboard design and the position of the button created.
v. Assessment of the human body for human-machine reacted can be improved.

CHAPTER II

LITERATURE REVIEW

2.1 What is Ergonomics?

Definition of the ergonomics can briefly defined as a branch of the science of work: “of the people who do it and the way it is done, tool and equipment they use, the places they work in, and the psychosocial aspect of the working situation” (Pheasant S. 2006). The ergonomics word comes from the Greek word, ***ergos*** mean work and ***nomos*** mean natural law. So that ergonomics is a study from engineering, medicine and the human sciences. In general ergonomics as a science anxious with human work, work involves the uses of tool and concerned with the design of the tools.

The ergonomic approach to design may be summarized in the ***principle of centered design:***

If an object, a system or an environment is intended for human use, then its design should be based upon the physical and mental characteristics of its human users (insomuch as these may be determined by investigative method of the empirical sciences).

(Pheasant S. 2006)

The objective of the investigation in ergonomics is to reach the best possible match between the *product* (object, system, or environment) being design and its users. This statement can be easily described by this figure:

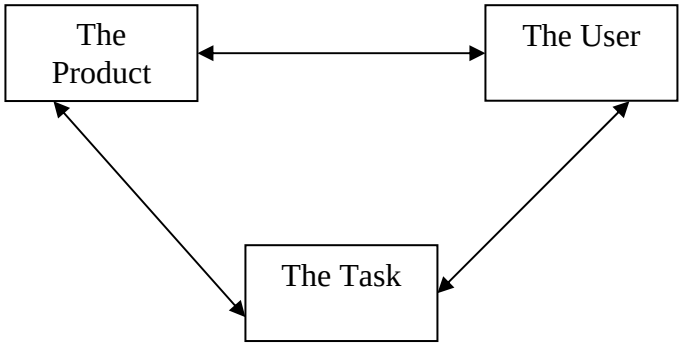

Figure 2.1: User-centered design: the product, the user, the task

2.1.1 Criteria Define a Successful Match

What are the criteria that can be define a successful match between products being designed and its user. There are some circumstances. Criteria that are commonly important in achieving a successful match include the following:

- Function efficiency (Productivity, task performances)
- Easy to use
- Comfort
- Health and safety
- Quality of working life

The ergonomics approach is to consider all relevant criteria, not simply to design for one criterion. Appropriate the job to the drivers involves consideration of health and quality of working life just as much as of productivity, and efficiency and quality of performance are influenced by all three: the product, the user, and the task. (*Figure 2.1*)

2.2 Introduction to the Ergonomics Design

With high and fast quality computer graphics there's no impossible that allow us to present the images wanted to analyzed and performed multitasks of analysis for ergonomics design.

From the various statistical descriptions (population attribution) such as size, shape, races, and dimension "thus it now possible to generate hominoids, or avatars, as some like to call them, to predict the performance capabilities of designated groups of people within a computer rendered environment" (B. Chaffin, 2001); on his book *Digital Human Modeling for Vehicle and Workplace Design* explain that possible to generated the manikins or hominoids with various statistical description (sized, shape, etc..) for ergonomics analysis by using certain software.

There are many of methods and software that can analyzed the ergonomics design for automotives application that will be covered in this chapter.

2.3 Computer Aided Ergonomics (CAE)

2.3.1 RAMSIS

Human Solutions has developed various solutions especially for the automotive industry. **RAMSIS (Realistic Anthropological Mathematical System for Interior Comfort Simulation; German Model)** is the standard solution for the ergonomic design of vehicle interiors. More than 70% of all car manufacturers worldwide now use **RAMSIS**. **RAMSIS** enables the realistic rendering of international body measurement data and efficient analysis of visibility, comfort and ergonomics.

Nowadays, computer-based manikins are very often used in the development of vehicle interiors, aircraft cockpits, passenger compartments and

workplaces. Besides the decline of product development time spans and development costs, manikins contribute to increasing the quality of the work environment and the user-friendliness and serviceability of the products. **RAMSIS** is the leading ergonomics tool worldwide and has been used during the development of passenger cars, trucks, aircraft and construction machinery for many years.

Figure 2.2: Preview of the **RAMSIS** solution for ergonomics design of vehicles interior

2.3.1.1 RAMSIS Application

RAMSIS Automotive is a CAD manikin specially developed for the ergonomic analysis of cars. Applications range from the ergonomic design of driver and passenger areas to an entire design for efficient preventative and corrective maintenance work. **RAMSIS** is not only available to the user as a pure CAD application (e.g. integrated into CATIA or as a stand-alone version) - as **RAMSIS in VR**, this ergonomics system can

also be used for real-time tests in the virtual reality laboratories of automotive manufacturers.

RAMSIS has a wide variety of anthropometric data of the most important global regions like for example, Asia, North America and Europe. Easily operate and statistically functions enable the generation of digital images of customer groups and their integration into the entire design and product development process.

After positioning of the **RAMSIS** manikin in the work environment, the user has widely differing analysis functions to choose from; like the calculation of space and room needs, accessibility envelopes, direct and indirect manikin view and the simulation of posture-contingent maximum available force. These analytical functions provide the user with extensive information about the ergonomic quality of the product and possible critical aspects of the design.

RAMSIS can run on many platforms and the software can be easily and efficiently integrated into your development process chain. **RAMSIS** is available as a stand-alone version on UNIX or Windows platforms and as a fully integrated ergonomics tool in CATIA V4 and V5.

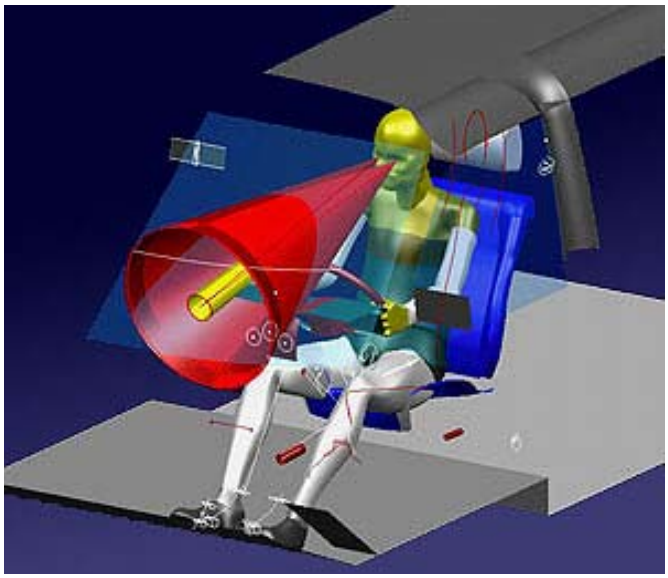

Figure 2.3: **RAMSIS** driving posture integrated with CATIA V5

2.3.2 SAMMIE CAD

SAMMIE being developed by Case, Porter, and Bonney at Nottingham and Loughborough Universities in the United Kingdom (UK) same general period 3DSSPP^{TM} were developed in United States (U.S). The **SAMMIE** system is a computer based Human Modeling tool. Its capabilities make it an invaluable tool to engineers and design teams working on products that are used by people. **SAMMIE** approach general model for assessing various reach, interference, and sight line issues key in by the engineers. It uses a complex statistical method to assemble the population anthropometric data needed to predict the percentile size and shape of given somatotype subgroups of interest. The system offers the following advantages:

i. 3D analysis of fit, reach, vision and posture.
ii. Reduced timescale.
iii. Early input of ergonomics expertise.
iv. Rapid interactive design.
v. Improved communication.
vi. Cost effective ergonomics.

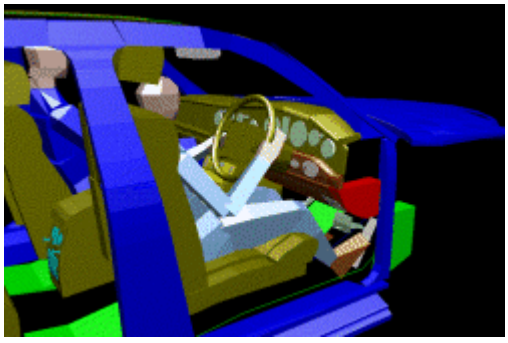

Figure 2.4: **SAMMIE** Posture concept in proposed vehicles

2.3.2.1 Advantages of SAMMIE CAD

i. Product concepts can be built within SAMMIE or imported from an external CAD system and rapidly assessed.
ii. A complete variety of human manikins can be created to simulate any age, gender, nationality, and body shape.
iii. Ergonomics input is provided right from the concept stage of design reducing the likelihood of expensive or unfeasible modifications being necessary at downstream stages.
iv. The system promotes the exploration of a wide range of design solutions.
v. The systems support the 3D analysis of complex tasks.
vi. The combination of product concepts populated with human manikins provides an excellent forum for all members of the design team.
vii. The ergonomics issues can be investigated throughout the design process as a result promoting the 'right first time' philosophy.

2.3.3 3DSSPP™

3DSSPP software predicts static strength requirements for tasks such as lifts, presses, pushes, and pulls. The program provides an approximate job simulation that includes posture data, force parameters and male female anthropometry. Output includes the percentage of men and women who have the strength to perform the described job, spinal compression forces, and data comparisons to NIOSH (U.S. National Institute of Occupational Safety and Health) guidelines. The user can analyze torso twists and bends and make complex hand force entries. Analysis is aided by an automatic posture generation feature and three dimensional human graphic illustrations.