FACTORS AFFECTING COMFORT LEVEL AND PERFORMANCE: A COMPARISON BETWEEN FOUR DIFFERENT TYPES OF COMPUTER MOUSE

MOHAMMAD ZABRI BIN JOHARI

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(TANDATANGAN PENULIS) (TANDATANGAN PENYELIA)

Alamat Tetap:
No. 142, Lrg. 5B, Jln Menggriss, Tmn. Sri Wangi, Petra Jaya, 93050, Kuching, SARAWAK.

Tarikh: 25/3/03. Tarikh: 25/3/05.
FACTORS AFFECTING COMFORT LEVEL AND PERFORMANCE: A COMPARISON BETWEEN FOUR DIFFERENT TYPES OF COMPUTER MOUSE

by

MOHAMMED ZABRI BIN JOHARI

This project is submitted in partial fulfillment of the requirements for a Bachelor of Science (Honors) in Cognitive Science/Human Resource Development/Organizational Counseling Faculty of Cognitive Sciences and Human Development, Universiti Malaysia Sarawak
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Also, I would like to thank my partner in crime, Christina Anthony. Thank you for being there when I need you most, and when you need me, I'm there.

I would like to thank all of my friends who were involved directly or indirectly in the making of this Final Year project so it would reached its final end, the finished product.

Finally, I would like to thank my parents for giving all of their love and support throughout the entire project.

Received for examination by:

[Signature]

Pn Shafziti Aman

Date:

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# TABLE OF CONTENTS

**Acknowledgement** vii  
**Table of Contents** viii  
**List of Figures** xi  
**List of Tables** xii  
**Abstract** xiv  
**Abstrak** xv  

I. **Introduction** 1  
1.1 Problem Statement 2  
1.2 Objectives of the Research 3  
   1.2.1 General Objectives 3  
   1.2.2 Specific Objectives 3  
1.3 Questions Imposed for the Research 3  
1.4 Research Hypothesis 4  
1.5 Definitions 4  
   1.5.1 Human – Computer Interaction 4  
   1.5.2 Ergonomics 5  
   1.5.3 Human/User Performance 5  
   1.5.4 Usability 5  
   1.5.5 Functionality 5  
1.6 Importance of the Study 5  
1.7 Limitations of the Study 6  
1.8 Conceptual Framework 7  
1.9 Summary 7  

II. **Literature Review and Previous Studies** 8  
2.1 Related Theories 8  
   2.1.1 Man – Machine Systems 8  
   2.1.2 Ergonomics 9  
   2.1.3 Usability Testing Control 9  
2.2 Related Previous Studies 10  
   2.2.1 Control 10  
   2.2.2 Shape of the Computer Mouse 10  
   2.2.3 Size and Weights of the Computer Mouse 12  
   2.2.4 Functions of the Computer Mouse 12  
2.4 Summary 12  

III. **Methodology** 13  
3.1 Research Design 13  
3.2 Research Location 13  
3.3 Research Subject Selection 13  
3.4 Research Tools – Experimentation Apparatus and Procedure 14  
3.5 Questionnaire 16  
   3.5.1 Part I – Demography 16  
   3.5.2 Part II – Evaluative Questions 16  
   3.5.3 Part III – Open Ended Questions 17  
3.6 Pilot Testing 17  

viii
7. Appendix

Figure 1
The original mouse.

Figure 2
Image of Doug Engelbart.

Figure 3
The conceptual framework of the study.

Figure 4
The man-machine loop.

Figure 5
The various types of computer mouse.

Figure 6
The tracking ball.

Figure 7
Mouse dragging task.

Figure 8
A smooth surface area for the design of the ergonomic mouse by Comfort.
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>1</td>
</tr>
<tr>
<td>The Original Mouse</td>
<td></td>
</tr>
<tr>
<td>Figure 2</td>
<td>6</td>
</tr>
<tr>
<td>Image of Doug Engelbart</td>
<td></td>
</tr>
<tr>
<td>Figure 3</td>
<td>7</td>
</tr>
<tr>
<td>The Conceptual framework of the study</td>
<td></td>
</tr>
<tr>
<td>Figure 4</td>
<td>8</td>
</tr>
<tr>
<td>The ‘man – machine loop’</td>
<td></td>
</tr>
<tr>
<td>Figure 5</td>
<td>14</td>
</tr>
<tr>
<td>The various types of computer mouse</td>
<td></td>
</tr>
<tr>
<td>Figure 6</td>
<td>15</td>
</tr>
<tr>
<td>Mouse Clicking Task</td>
<td></td>
</tr>
<tr>
<td>Figure 7</td>
<td>15</td>
</tr>
<tr>
<td>Mouse Dragging Task</td>
<td></td>
</tr>
<tr>
<td>Figure 8</td>
<td>34</td>
</tr>
<tr>
<td>A Solidwork surface scan for the design of the ergonomic mouse by Coughley</td>
<td></td>
</tr>
</tbody>
</table>
LIST OF TABLES

Table 1 16
The four-point Likert Scale

Table 2 19
Frequency of the subjects Age Group

Table 3 19
Subject’s Sex involved in the experiment

Table 4 20
Frequency of Computer Usage Experience among subjects

Table 5 20
Computer Usage Frequency per day among subjects

Table 6 20
Computer usage purpose based on importance

Table 7 21
Distribution and mean value of subject agreeing to size affecting performance

Table 8 22
Distribution and mean value of subjects agreeing to shape affecting comfort level

Table 9 23
Distribution and mean value of subjects agreeing to size affecting performance

Table 10 24
Distribution and mean value of subjects agreeing to size affecting comfort level

Table 11 25
Distribution and mean value of subjects agreeing to weight affecting performance

Table 12 26
Distribution and mean value of subjects agreeing to weight affecting comfort level

Table 13 27
Distribution and mean value of subjects agreeing to functions affecting performance
Table 14
Distribution and mean value of subjects agreeing to functions affecting comfort level

Table 15
Summary of Mouse A

Table 16
Summary of Mouse B

Table 17
Summary of Mouse C

Table 18
Summary of Mouse D

Table 19
Mean Average score of relationship of Performance against Mouse Shape

Table 20
Mean Average score of relationship of Performance against Mouse Size

Table 21
Mean Average score of relationship of Performance against Mouse Weight

Table 22
Mean Average score of relationship of Performance against Mouse Functions

Table 23
Mean Average score of relationship of Comfort Level against Mouse Shape

Table 24
Mean Average score of relationship of Comfort Level against Mouse Size

Table 25
Mean Average score of relationship of Comfort Level against Mouse Weight

Table 26
Mean Average score of relationship of Comfort Level against Mouse Functions

Table 27
The overall results from the hypotheses analysis
ABSTRACT

FACTORS AFFECTING COMFORT LEVEL AND PERFORMANCE: A COMPARISON BETWEEN FOUR DIFFERENT TYPES OF COMPUTER MOUSE

MOHAMMAD ZABRI BIN JOHARI

This study is carried out to assess the usability factors that contribute to the performance and comfort level of the users using four types of computer mouse. The factors that are assessed are size, shape, weight and function that contribute to performance and comfort. The study also aims to look for the best type of computer mouse from the four selected. The sample study comprises of 20 randomly chosen students from Universiti Malaysia Sarawak. A questionnaire is distributed for the purpose of data collection for this study. The questionnaire is self-developed and it functions to measure the respondent's background and the computer mouse characteristics that are to be evaluated. A descriptive statistical method comprising of percentage and frequency is used to provide a summary for the overall set of data and the effects of each characteristics on the performance and comfort level for each type of computer mouse. An average mean score analysis is used to determine whether there exist any significant (strong/weak) relationship between each factor with the performance and comfort level. The researched findings revealed that size, shape, weight and functions do have a strong relationship with performance with the exception of weight for the relation with comfort level. From the findings as well it was revealed that the best type of mouse is the ergonomic optical mouse.
ABSTRAK

FACTORs AFFECTING COMFORT LEVEL AND PERFORMANCE: A COMPARISON BETWEEN FOUR DIFFERENT TYPES OF COMPUTER MOUSE

MOHAMMAD ZABRI BIN JOHARI

CHAPTER 1
INTRODUCTION

1.0 Introduction to the Computer Mouse

The Computer mouse was born in the Stanford Research Institute (SRI) in 1963 and created by the 'father' mouse, Douglas C. Engelbart. It was not until 1964 that the first working prototype of the mouse was made to use with a graphical user interface (GUI) 'windows'. Engelbart received a patent for the wooden shell with two metal wheels (computer mouse) in 1970, describing it in the patent application as an "X-Y position indicator for a display system." "It was nicknamed the mouse because the tail came out the end," Engelbart revealed about his invention. His version of windows was not considered patentable (no software patents were issued at that time), but Engelbart has over 45 other patents to his name (Bellis, 2002).

Figure 1: Image acquired from Mice in the Fast Lane: The Evolution of Computer Input Devices website (http://www.p2pr.com/eur/it/)

The development of computers nowadays has been rather extensive and is still expanding into newer heights. Various innovations in the computer systems, peripherals and software are making computers more and more high-ended each time a new model comes out, but at the same time the developers try to make it easier to use for the customers. One of the peripheral that is making new
innovations by the month is the input device that is better known as the computer mouse.

The computer mouse made its mark in the early 60's and has become the most popular and recognizable pointing devices, hence making it more common in use. Innovations made by developers of the computer mouse are trying to make it more and more advanced, both in aesthetics and in functionality.

There are a variety of computer mouse available on the market. For the purpose of this study, four will be assessed. A traditional mouse that has the basic functions with nothing else added, a mini mouse that small is size and very light, a designer shaped mouse which was created for more aesthetics than functionality, and an optical mouse that is designed to many purposes with extra added functions. Not all of these mice is user fitting. Each computer mouse will be assessed to find which mouse is the best.

This study aims to assess the factors that affect user's comfort level and performance when using different types of mouse. The study will also take into account the structural aspects of the computer mouse that affect the user's performance and comfort level. The main question in this research is which type of mouse the user (in general) is more comfortable using.

This research is done solely on the inquisitive need to know what constitutes the make up of an ergonomic mouse, how would it be able to take in the highest regards in functionality, usability, feel, user performance and aesthetics.

It is hoped that this study would inspire future researchers to find more interesting aspect that can be modified for the computer mouse, unless the computer mouse has become obsolete and replaced by a new, better performing pointing device. If not, then it is hoped that there would be a researcher that would dwell deeper in the functionality, usability, aesthetics and unnoted limitations from this study.

1.1 Problem Statement

The various types of computer mouse come with various benefits and consequences. Some designs of the computer mouse do not fit both the categories of functionality and structural aspects. So users tend to buy a computer mouse without regarding what consequences they might face when using it. For example, a user buying a mini mouse with later was having the problem of using it because the user's palm is too big.

Each computer mouse, with its own benefits and weakness will be studied on the various factors that will determine which is the best. This study aims to assess the user's performance and comfort level when using different types of computer mouse. The answer to the question which will be sought in this research is whether a specific kind of mouse, with its own special features determines the performance and the level of comfort of the user using the mouse.

1.2 Objectives of the Study

1.2.1 General Objective

The general objective of this study is to determine user's performance and comfort level when using different types of mouse; the standard scroll wheel mouse, mini mouse, designer shaped mouse and an optical mouse. The main question contributing to the study is which type of mouse has the highest performance and comfort level in terms of structural and functional aspects.

1.2.2 Specific Objectives

Specifically this research aims to:

i). The performance of a mini mouse.
ii). The performance of a designer shaped mouse.
iii). The performance of an optical mouse.
iv). The performance of a standard scroll wheel mouse.
v). The comfort level of a mini mouse.
vi). The comfort level of a designer shaped mouse.
vii). The comfort level of an optical mouse.
viii). The comfort level of a standard scroll wheel mouse.

1.3 Questions Imposed

Some of the questions that arise in this research are:

i). Is there an increase in performance when using a mini mouse?
ii). Is there an increase in comfort when using a designer shaped mouse?
iii). Is there an increase in performance and comfort when using an optical mouse?
iv). Is there an increase in performance when using a standard scroll wheel mouse?
v). Is there an increase in use of different functions possible when using a designer mouse?
vi). Is there an increase in comfort when using a standard scroll wheel mouse?
1.2 Objectives of the Research

1.2.1 General Objective

The general objective of this study is to determine the factors affecting the user's performance and comfort level when using the different types of computer mouse: the standard scroll mouse, the 'mini' mouse, a designer made mouse, and an optical mouse. The aspects that are going to be assessed are the structural aspect that contributes to the following factor: usability and functionality.

1.2.2 Specific Objectives

Specifically this research aims to study the user's performance and comfort level in terms of structural aspects:

i). The performance level with relations to the shape of the computer mouse.
ii). The performance level with relations to the size of the computer mouse.
iii). The performance level with relations to the weight of the computer mouse.
iv). The performance level with relations to the functions provided to the computer mouse.
v). The comfort level with relations to the shape of the computer mouse.
vi). The comfort level with relations to the size of the computer mouse.
vii). The comfort level with relations to the weight of the computer mouse.
viii). The comfort level with relations to the functions provided of the computer mouse.

1.3 Questions Imposed on the Research

Some of the questions that arose from this research are:

i). Is there any relationship between the user's performance and shape when using different types of mouse?
ii). Is there any relationship between the user's performance and size when using different types of mouse?
iii). Is there any relationship between the user's performance and weight when using different types of mouse?
iv). Is there any relationship between the user's performance and functions provided when using different types of mouse?
v). Is there any relationship between the user's comfort level and shape when using different types of mouse?
vi). Is there any relationship between the user's comfort level and size when using different types of mouse?
vii). Is there any relationship between the user's comfort level and weight when using different types of mouse?

viii). Is there any relationship between the user's comfort level and functions provided when using different types of mouse?

1.4 Research Hypothesis

This research aims to prove the factors affecting the user's performance and comfort level when using different types of mouse. The hypotheses are listed as below:

$H_0 = \text{There is no significant relationship between the user's performance and mouse shape when using different types of mouse.}$

$H_0 = \text{There is no significant relationship between the user's performance and mouse size when using different types of mouse.}$

$H_0 = \text{There is no significant relationship between the user's performance and mouse weight when using different types of mouse.}$

$H_0 = \text{There is no significant relationship between the user's performance and mouse functions provided when using different types of mouse.}$

$H_0 = \text{There is no significant relationship between the user's comfort level and mouse shape when using different types of mouse.}$

$H_0 = \text{There is no significant relationship between the user's comfort level and mouse size when using different types of mouse.}$

$H_0 = \text{There is no significant relationship between the user's comfort level and mouse weight when using different types of mouse.}$

$H_0 = \text{There is no significant relationship between the user's comfort level and mouse functions provided when using different types of mouse.}$

1.5 Definitions

1.5.1 Human-Computer Interaction

Human-Computer Interaction can be defined as a set of processes, dialogues, and actions through which a human user employs and interacts with a computer ([Baecker & Buxton, 1987], in Preece, 1998). A more broader and recent definition of Human-Computer Interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them [(ACM SIGCHI, 1992), in Preece, 1998]. Human-Computer Interaction is a field studying all aspects of interaction happening when the user uses a system or product.

1.5.2 Ergonomics

The Ergonomic factor of concerns in order to [Dictionary, 1995]. This explains the relationships machinery that provides also known as 'a study on' ergonomics is to reduce reliability (Oborne, 1995) Human-Computer Interaction.

1.5.3 User/Human Performance

User or Human Perf use regards to a person using In the context of this research, user when using the different types of computer mouse when using the computer.

1.5.4 Usability

Preece (1998) defines system can be learned about attitude of its users towards main principles in User-Computer Interaction can be used easily or not by user learning, using and what to expect the different kind of computer.

1.5.5 Functionality

Functionality is referable to perform its function sitting only and not for an functionality of the computer function than what it should.

1.6 Importance of the title

The importance of different types computer mouse from mi
1.5.2 Ergonomics

The Ergonomic factor by definition is the study of work and working conditions in order to improve people’s efficiency (Oxford Advance Learner’s Dictionary, 1995). This definition is adapted from the scientific definition that explains the relationship of the environment and workplace, the tools and machinery that provides a comfort fit to the worker (Lund, 1990). Ergonomics is also known as ‘a study of how people interact with machines’. A further aim of ergonomics is to reduce operator unpredictability, in other words to increase reliability (Oborne, 1995). Two of the sub disciplines in Ergonomics are Design and Human-Computer Interaction.

1.5.3 User/Human Performance

User or Human Performance the level of ability to operate efficiently in regards to a person using something (Oxford Advanced Learner’s Dictionary, 1995). In the context of this research it is the achievement level in performance of the user when using the different types of mouse when given a specific task. Performance in this study refers to the quality and productivity level of the user when using the computer mouse to the given task.

1.5.4 Usability

Preece (1998) defines usability as ‘a measure of the ease with which a system can be learned or used, its safety, effectiveness and efficiency, and the attitude of its users towards it. Usability can also be defined as ‘One of the three main principles in User-Centered-Design. It determines whether the product can be used easily or not by users (Norman, 1988). This brings the concept of ease in learning, using and what the user might expect when using a computer mouse, and the different kind of computer mouse.

1.5.5 Functionality

Functionality is referred as by Donald Norman (1988) as the product being able to perform its function within is specific limits. For example a stool is for sitting only and not for any other purpose. This is the same for the study where the functionality of the computer mouse will be tested, whether its serves any other function than what it should be.

1.6 Importance of the Study

The importance of this study is to evaluate the reliability of the many different types computer mouse that is on the market and its effect on the user’s performance level and comfort level. Since 1964, there are over 50 types of computer mouse from many different computer mouse manufacturers. Many of
these mouse do not fit 100 percent within the criteria of usability, functionality, comfort and aesthetics.

This study also intends to inform the public of which type of mouse can provide the best performance and comfort level. This study also aims to create awareness for developers on the importance of ergonomics in the design of the computer mouse and not concentrate on the aesthetics and additional functions.

Figure 2: Image acquired from Mice in the Fast Lane: The Evolution of Computer Input Devices website (http://www.p2pr.com/eur/it/)

1.7 Limitations of the Study

This research will be conducted in the premises of University Malaysia Sarawak (UNIMAS), where the study will be conducted locally. Even though the study is conducted in the local premises of UNIMAS, the results can also be used in the population in general as the test conducted in this study is very general and does not require any special ability.

This study will only use four type of computer mouse, whereas in the market there is over 50 kinds of computer mouse. Since the study concentrates on the usability, functionality, comfort and aestheticsness it is sufficient that the four types (standard scroll, etc.)

The honesty of the why the results of this study.

1.8 Conceptual Frame

Figure 5 below shows this study.

Independent Variables

Figure 3

1.9 Summary

The extensive research design for the computer aims to assess which type aims to see the significant of the user with the shape of the user with the shape.
four types (standard scroll, mini, designer, and ergonomic mouse) are used for the study.

The honesty of the participants in this study may be doubted as well. That is why the results of this study depend solely on the honesty of the participants themselves.

1.8 Conceptual Framework

Figure 5 below shows the conceptual framework that will be examined in this study.

![Conceptual Framework Diagram]

**Figure 3: The conceptual framework of the study**

1.9 Summary

The extensive research of the computer has lead to the study of creating new design for the computer mouse. With the various types of mouse, this research aims to assess which type of mouse is best fitted to any user. This research also aims to see the significant relationship between the performance and comfort level of the user with the shape, size, weight and functions of the computer mouse.
CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

In this chapter, a collection of literature review is shown for the purpose of providing an insight to the current study based on previous works by other researchers. Besides that, there are explanations to theories that are related and will be used in the study.

2.1 Related Theories

2.1.1 Man-Machine Systems

A man-machine system describes the interaction of man with the machine. By linking the machine to the person in this way (and in this direction) a relationship is established between the two components, so that the machine presents information to the operator via the operator's sensory apparatus to which a response may be made in some way - perhaps to alter the machine's state via the controls (Oborne, 1995). This study aims to test the fundamentals functions of the computer mouse that affects the user's performance and comfort level.

![Diagram of the 'man-machine loop'](image)

Figure 4: The 'man-machine loop'. The machine displays information to the operator who uses controls to affect the machine. The environment can interfere with the efficiency of this loop.
2.1.2 Ergonomics

Ergonomics in a broader sense is the interaction between man and the tools or machines that they use at work or in their everyday lives. By definition, ergonomics was derived from the Greek word *ergon* – work and *nomos* – natural laws. However this term cannot be classified as a new term as Seminara (1979) points out that it was first used in Poland by Professor Wojciech Jastrzebowski in an article published in 1857 (Oborne, 1995).

As ergonomics is becoming more recognized by the product developing communities, it is essential to be incorporated into any design of any product, no matter if it is physical or not. Ergonomic of today is an amalgam of physiology, anatomy and medicine as one branch; physiological and experimental psychology as another; and physics and engineering as a third.

As stated in Preece’s (1998) *Human Computer Interaction*, the problems with designs can be categorized as below:

i). People vary in many forms,

ii). People come in different shapes and size,

iii). People come from different cultures,

iv). People have different perspectives from one another,

v). People come from different professions,

vi). People have different pursuits in life; or when using a product.

Failure to overcome this barrier will cause the product to cause possibly more problems that it tries to achieve solving. This study attempts to check the barriers of the design in the computer mouse and identify the weaknesses.

2.1.3 Usability testing

Ergonomists always seem to evaluate things; where a product went wrong and try to think out the various ways of improving that certain product. According to Preece and Keller (1990), usability is referred to as how easy it is for humans to use a certain product. This closely related to how the user finds the ease of usage with the computer mouse, how the mouse is presented to the user and how well the user can cope with the design and performance of the mouse.

To evaluate usability, it is imperative to evaluate every aspect and situation where the computer mouse is used by the user and find out where the flaws of the computer mouse are and figure out an explanation or possible solution the problem.

Some of the questions that can be used for testing the usability of the computer mouse are:

i). Can the user use the computer mouse with ease?

ii). Can the user have a controlled grip when using the mouse?

iii). Were there errors and how often does the error occur when using the computer mouse?

iv). Is the design of the computer mouse is causing any discomfort to the user?

v). Can the task appointed to the user done in equal time and accurately with the use of each mouse?


2.2 Related Previous:

2.2.1 Control

Control play an important role in the system effectively. In this section, we’ll explain the concept of control and how it affects the human posture while using the computer mouse.

A quality control mechanism is a system to ensure even good interaction with the user with respect to control: touch, reach and control. A similar study made by Professor Alan Hedge (1994) stated that most users face problems related to control: touch, reach and control.

Norman (1988) stated that control is correlation in a form that is understandable for the user. This is to prevent repetitive strain injuries.

On a previous study by Hedge (1994) stated that most users face problems related to control: touch, reach and control. This is to prevent problems happening.

2.2.2 Shape of the Computer Mouse

In ergonomics, the shape of the computer mouse mechanisms. Oborne (1995) stated the way in which an operator interacts with the computer mouse affects overall performance and comfort.

A similar study made by Professor Alan Hedge (1994) stated that the use of a non-ergonomic shaped mouse (The Whale Mouse) reduces the risk of wrist injury.

The subjects were a group of 24, including 12 males and twelve females, who were asked to complete their tasks with a non-ergonomic shaped mouse and an ergonomic shaped mouse. The subjects were asked to complete their tasks in a comfort level and the hand.”

The result of this study was that Hedge called “skating on these same tasks” and that Hedge called “skating on the Whale Mouse reduces the risk of wrist injury.”

vi). Are each mouse equal?

vii). Are there any aspects?

viii). Is there any relation?

ix). Are there any relations between the extra functions, design and the ergonomic posed by the other user?
vi). Are each mouse equal in all instances?

vii). Are there any aspects that can be upgraded or modified with each mouse?

viii). Is there any relationship with the performance level and the motivation (i.e. extra functions, design) provided by the use of each computer mouse?

ix). Is the ergonomic mouse used in the study the best solution to the problems posed by the other computer mouse?

2.2 Related Previous Studies

2.2.1 Control

Control play an important role in aiding the user to use any given product or system effectively. In the case of this study, the control is the computer mouse itself. A quality control not only has a level of standard but also allows proper or even good interaction with the user. The control item will give a proper feedback to the user with respect to the proper instructions given. For example, when the mouse is moved downwards across the mouse pad, the pointer must also follow suit indicating it is giving proper feedback.

Norman (1988) stated that a good control not only is easy to use but is also in a form that is understandable and is fit to receive response from the system. This is to prevent repetitive mistakes.

On a previous study on the control was done by Tan Wee Meng (1997). He stated that most users fail to choose the proper controls. This is why the physical control: touch, reach and hold must be suitable and in comfort with the user. This is to prevent problems happening as in barrier of usage.

2.2.2 Shape of the Computer Mouse

In ergonomics, the shape that is studied is in the form of control mechanisms. Oborne (1995) stated that shape can have an important influence on the way in which an operator uses the control. This in turn, as Oborne stated, affects the human posture. In the end, the shape of the control will affect the overall performance and comfort level of the users themselves.

A similar study made on the shape of the computer mouse was conducted by Professor Alan Hedge (1999). His study was a comparative study focused on stress reduction with the usage of two mice: the Microsoft Computer Mouse and a flatter shaped mouse (The Whale Mouse). The study had twenty four (24) samples (twelve (12) males and twelve (12) females). The subjects were positions at their own comfort level and the handbreadth were measured for standardization.

The subjects were also given oral instructions on the task provided. The data collected include task completion time and error percentage for performance. Subjective assessment was made on the comfort level and preference.

The result of this study revealed that the flatter and adjustable surface of the Whale Mouse reduces wrist extensions postural risks associated with mouse use. This is based on the fact that the Whale Mouse discourages the movement that Hedge called “skating” or “flicking” of mouse movements, which may increase the risk of wrist injury.
2.2.3 Size and Weight of the Computer Mouse

Sizes, or control sizes and dimensions clearly need to be related to the anthropometric dimensions of the limb used (Oborne, 1995). The size of the control mechanism, in this case the mouse, determines the gripping continuum of the control mechanism to the task assigned. If the gripping ability of the control mechanism is lowered due to the size, performance and comfort level will be affected significantly.

Oborne (1995) stated that the weight of many controls becomes important only when the inertia is enough to cause undue resistance, otherwise the weight will be supported by the machine itself. However, some controls are used away from a machine (particularly hand-tools) and in these cases the tool's weight may obviously play an important part in its effectiveness. This is true when it comes to control mechanisms that functions by moving it around. Weight of hand-held tools or devices will cause the performance to be affected.

On a previous study that was made on the design of six different computer mice by Poika Isokoski and Roope Raisamo (2002); both scientists stated “ideally the shape, size and weight of the mice should be varied independently to make it easier to find the relative contributions of these factors”. The factors that were referred to are speed and accuracy.

The study conducted tested six computer mouse of which the shape, size and weight were recorded. The software used for the experiment was of written type: C++ and GTK++. The subjects also given subjective rating on each type of mouse that they prefer. The procedure included the usage of standardization from the ISO 9241 for computer mouse rating scale. Data collected are from the computer mouse pairs assessed from the throughput, pointing time and error rate.

The results of the study showed that the shape, size and weight do have significant impact on the performance and error rate made by the subjects. The comfort level is also affected by the shape, size and weight of the computer mouse.

2.2.4 Functions of the Computer Mouse

In ergonomics Norman (1988) has defined functions as the characteristics of which the users are able to know which part of a product can be operated and how it is operated. With adequate functions, the task given to the user will increase the performance level and may increase the comfort level of the user as well.

Shumin Zhai and I. Scott MacKenzie (1998) have written a paper on increasing the functionality of the computer mouse. Even though their paper concentrates on the increasing the degrees of freedom of the computer mouse for 3D viewing, their study provides an important view on adding more tactile feedback on the functions of the computer mouse, scrolling and zooming capabilities.

They referred the computer mouse as an “old technology”. Their paper suggested that the new trick that can be added to the computer mouse adding three-dimensional properties to the mouse which is available now in several type mouse on the market. New innovations for the functions of the computer mouse include making the mouse scroll.