



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**REDESIGN OF ASSISTIVE DEVICE FOR BLIND PEOPLE
USING CONCEPT OF ENGINEERING DESIGN**

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

by

TEE SUI FAN

B071410308

941030-01-5065

FACULTY OF ENGINEERING TECHNOLOGY

2017

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

**TAJUK: Redesign Of Assistive Device for Blind People Using Concept
Of Engineering Design**

SESI PENGAJIAN: 2016/17 Semester 2

Saya **TEE SUI FAN**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. ****Sila tandakan (✓)** (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
 SULIT (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
 TERHAD
 TIDAK TERHAD

Disahkan oleh:

Alamat Tetap:

35, Jalan Kelapa Puyuh

Taman Soga,

83000 Batu Pahat, Johor.

Tarikh: _____

Cop Rasmi:

Tarikh: _____

**** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.**

DECLARATION

I hereby, declared this report entitled “Redesign of Assistive Device for Blind People Using Concept of Engineering Design” is the results of my own research except as cited in references.

Signature :

Author' s Name : TEE SUI FAN

Date :

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering Technology (Product Design) with Honours. The member of the supervisory is as follow:

.....
(MOHD KAMAL BIN MUSA)

ABSTRAK

Pada era yang semakin canggih ini, terdapat pelbagai alat bantuan dipasarkan dalam pasaran bagi membantu orang buta berjalan seperti orang biasa dan mengelakkan mereka daripada terlanggar halangan sekeliling. Namun, apabila membawa alat bantuan tersebut, ia akan menjadi satu bebanan bagi orang buta jikalau reka bentuk alat bantuan tersebut dicipta secara tidak ergonomik. Pengguna akan rasa tidak selesa apabila membawa alat bantuan dengan mereka. Dengan ini, projek ini akan mencadangkan beberapa reka bentuk bagi menaikkan keselesaan “Smart Vibration System Goggles”. Komponen yang sedia ada dalam sistem ini juga akan diubahsuai dengan mengekalkan fungsi sistem tersebut. Survey telah dijalankan untuk memahami keperluan dan keinginan reka bentuk cermin mata untuk orang buta. Dengan ini, beberapa lakaran tentang reka bentuk cermin mata telah dicadangkan. Apabila reka bentuk produk dimuktamadkan, model CAD produk tersebut akan dijana dalam SolidWorks. Semua dimensi produk akan ditentukan pada masa ini dengan mengambil kira komponen saiz. Selepas itu, produk yang telah siap ubah suai telah diuji oleh 15 responden. Secara keseluruhan, kepuasan reka bentuk produk ini telah meningkat sebanyak 53.33% (dari 20% hingga 73.33%)

Kata Kunci: alat bantuan, orang buta, reka bentuk, keselesaan, ubah suai.

ABSTRACT

Nowadays, there are a lot of assistive products on the market that used to help blind people to guide and prevent to bump into obstacles during their walking. However, when carrying these assistive products, sometimes it would become a burden for visually impaired people as the design of the products is not ergonomics. The users will feel uncomfortable and inconvenience when bringing the assistive device along with them. Thus, this project is conduct to improve the design of the Smart Vibration System inside the goggles so that the users will feel comfortable when wearing on it. The components inside the products will also be modify while remain its functionality. First, a survey has been done among the blind people to understand their needs and wants for the design of goggles. Then several designs idea have been proposed in sketches. Once it is finalized, a CAD model will be generated inside SolidWorks software. All the dimensions will be defined in this stage by considering the system components. Next, the modified product prototype is tested by 15 respondents. As results, the satisfaction of the new design of the goggles has increased from 20% to 73.33%.

Key words: Assistive device, visually impaired, comfortable, modify, satisfaction

DEDICATION

Every challenging work needs self-efforts as well as guidance of elders, especially those who very close to our heart.

My humble effort I dedicate to my sweet and lovely

Family members

Whose affection, encouragement and prayers of day and night make me able to get such success and honour.

Project supervisor, Encik Kamal Bin Musa

Project co-supervisor, Encik Wan Norhisyam Bin Abd Rashid

Along with all hardworking and respected

Lecturers and friends

ACKNOWLEDGEMENT

First of all, I would like to convey my appreciation to my family for their unconditional love, support and encouragement for being with me on each and every step of my life.

Meanwhile, I wish to express my deepest gratitude to my supervisor, Mohd Kamal Bin Musa for his guidance, motivation and help throughout my research. His insightful advice and suggestions allowed me to perform to my fullest potential.

Last but not least, I would like to thank all the lecturers and friends whoever help me throughout my education at Universiti Teknikal Malaysia Melaka.

TABLE OF CONTENT

DECLARATION	vi
APPROVAL	vii
ABSTRAK	viii
ABSTRACT	ix
DEDICATION	x
ACKNOWLEDGEMENT	xi
TABLE OF CONTENT	xii
LIST OF TABLE	x
LIST OF FIGURE	xi
LISTS OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE	xiv
CHAPTER 1	
<i>INTRODUCTION</i>	
1.0 Overview	1
1.1 Background	1
1.2 Problem Statement	2
1.3 Objective	3
1.4 Prototyping and fabricating the product scope	4
CHAPTER 2	
<i>LITERATURE REVIEW</i>	
2.0 Overview	5
2.1 Design	5
2.1.1 Product Design	5
2.1.2 Design Concept	7

2.1.3	Design Problem	7
2.1.4	Design Research	8
2.1.5	Integrating Ergonomics into Engineering Design	9
2.1.6	Goggles Design	10
2.2	Design Process	11
2.2.1	Engineering Design Process	11
2.2.2	Definition of Conceptual Design	12
2.2.3	Design Decision	14
2.3	Design Engineering Industry	14
2.3.1	Challenges in Design Engineering Industry	14
2.4	Engineering Device	15
2.4.1	Assistive Device	15
2.4.2	Components in the system	17
2.4.3	Comparative Study for others assistive Device	17
2.5	Visually Impaired People	18
2.5.1	Visually Impairment	18
2.5.2	Difficulties face by visually impaired people	20

CHAPTER 3

METHODOLOGY

3.0	Overview	21
3.1	Study Planning	21
3.1.1	Project Process Flow	21
3.2	Research Methodology	23
3.2.1	Problem Identification	24
3.2.2	Objective Setting	24
3.2.3	Literature Review	24
3.2.4	System of Product	25
3.2.4.1	Original Components	25
3.2.5	Design Research	28
3.2.5.1	Design Patent	28

3.2.5.2	Commercialization	28
3.2.6	System Redesign in Conceptual Stage	31
3.2.7	Design Survey	32
3.2.8	Analysis by using simulation	34
3.2.9	Software simulation	37
3.2.10	Prototyping	37
3.2.11	Result Satisfaction	38
3.2.12	Documenting and Reporting	38

CHAPTER 4

RESULT AND DISCUSSION

4.0	Overview	39
4.1	Design justification of original smart goggle	39
4.2	Experimental Result	40
4.2.1	The Angle elevated by the ultrasonic sensor	40
4.3	Data analysis	42
4.3.1	Parameter setting on the RULA analysis	42
4.3.2	Parameter setting on the original design of goggles	44
4.4	Design Justification	46
4.4.1	First CAD Model Design	46
4.4.2	Second CAD Model Design	47
4.4.3	Component matching	48
4.5	Modification in circuit	50
4.6	3D Printing	51
4.6.1	Setting in UP! Software	51
4.7	Printing filament	55
4.7.1	Effect of Printing Support	56
4.8	Prototype versus real life product	58
4.9	User experience	58
4.9.1	Testing on the original design of goggles	58

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion 62

5.2 Recommendation 63

REFERENCES 65

LIST OF TABLE

Table 3.1: Benchmark of Products	30
Table 3.2: Bills of Materials	31
Table 3.3: Needs and Wants of Customer	32
Table 4.2: Date received for distance of 1m	41
Table 4.3: Date received for distance of 3m	41
Table 4.4: Scoring of RULA analysis	45
Table 4.5: Properties of ABS and PLA plastic	56

LIST OF FIGURE

Figure 1. 1: The Block Diagram of Smart Vibration System.	2
Figure 1. 2: Original design of smart vibration system	2
Figure 2. 1: Anthropometry of Head	10
Figure 2. 2: The Design of Assistive Goggles	11
Figure 2. 3: Steps of the Engineering Design Process	12
Figure 2. 4: The Conceptual Design Stages	13
Figure 2. 5: The Function of Ultrasonic Sensor	17
Figure 2. 6: Types of Assistive Device	18
Figure 2. 7: Visually Impaired People	19
Figure 3. 1: Overall Project Process Flow	22
Figure 3. 2: Process Flow of the Project	23
Figure 3. 3: Ultrasonic Sensor	26
Figure 3. 4: Pager Motor	26
Figure 3. 5: GSM Module	27
Figure 3. 6: GPS	27
Figure 3. 7: Arduino Microcontroller	27
Figure 3. 8: Patent of Goggles	28
Figure 3. 9: Maxbotix LV-EZ 01	32
Figure 3. 10: Lipo Battery	32
Figure 3. 11: Morphological Chart	35

Figure 3. 12: Draft Design of Goggles	36
Figure 3. 13: The Finalize Design of Goggles	37
Figure 4. 1: Experiment on the angle detection of ultrasonic sensor	40
Figure 4. 2: Detection angle of ultrasonic sensor	42
Figure 4. 3: Box contain electronic components in original design of goggles	43
Figure 4. 4: Posture of manikin in RULA analysis	44
Figure 4. 5: Parameter setting of RULA analysis	44
Figure 4. 6: Final score of analysis	45
Figure 4. 7: Detail results of analysis	46
Figure 4. 8: First CAD design of goggles	47
Figure 4. 9: Nose Anthropometry	47
Figure 4. 10: Second CAD design of goggles	48
Figure 4. 11: Position of ultrasonic sensor and vibrator	49
Figure 4. 12: Position of Arduino board	49
Figure 4. 13: Position of Lipo-battery	50
Figure 4. 14: Position of switch, GSM and GPS module	50
Figure 4. 15: Comparison of Seal Lead Acid battery (left) and Lipo-battery (right)	51
Figure 4. 16: Comparison of Arduino board size for original design of goggle (left) and new design of goggles (right)	51
Figure 4. 17: Comparison of ultrasonic sensor for original design of goggle (left) and new design of goggles (right)	52
Figure 4. 18: Maximum printing size of software	52
Figure 4. 19: Left and right frames of goggles	53
Figure 4. 20: Upper part and lower part	53

Figure 4. 21: left and right part of hanger	53
Figure 4. 22: Top view	54
Figure 4. 23: Front view	54
Figure 4. 24: Side view	54
Figure 4. 25: Fill parameters in UP! 3D printing software	54
Figure 4. 26: Part parameters in UP! 3D printing software	55
Figure 4. 27: Support parameters in UP! 3D printing software	55
Figure 4. 28: Support that built inside the part are hard to remove	57
Figure 4. 29: Marks or damage after removing the supports	58
Figure 4. 30: Defect due to overheat of nozzle	58
Figure 4. 31: Marks that affect the exterior looking of product	59
Figure 4. 32: Problem faces when wearing on the original design of goggles	61
Figure 4. 33: Comparison of design satisfaction for both design of goggles	62
Figure 4. 34: Suggestion of improvement for design of goggles	63

LISTS OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

GPS	=	Global Positioning System
GSM	=	Global System for Mobile communication
RULA	=	Rapid Upper Limb Assessment
CAD	=	Computer Aided Design
STL	=	Stereo Lithography
M	=	Meter

CHAPTER 1

INTRODUCTION

1.0 Overview

In this chapter, the general idea of this project has been discussed and followed by the problem statement of this project. Next, the aim of this project has been explained clearly and the extent for implementation of this project has been stated.

1.1 Background

Visual Impairment is results from a disease, injury or other conditions that limit vision. According to the research of World Health Organization (WHO) in Prevention of Blindness and Deafness (PBD) Document 2010, 285 million people are estimated to be visually impaired worldwide, which 39 million are blind and 246 have low vision.

Disability of eyes will bring effects on their normal life as physical movement is one of the biggest challenges for blind people. Normally, visually impaired people used to memorize every structure detail in their house to prevent injury. However, what if a visually impaired people go to new places? The structural obstacles in natural or manmade environments such as trees or stairs will block the mobility of visually impair people. Hence, to ensure the visually impaired people can walk like normal people, a wearable system is developed to help them from bump into obstacles during the walk.

In existing design, the ultrasonic sensor of the goggles can detect obstacles at a certain distance from users and send vibrate signal to alarm the users. The vibrator will vibrate in different frequency depending on the location of the obstacle and it will be stop within 5 seconds right after the user has stay away or prevent from the obstacles successfully. In case, when the user has lost their way, they can press the button which locate at the box on the existing design. The GPS system will start to detect the longitude of user and transfer to the GSM-Arduino system. When the GSM-Arduino system had received the location of user, it will send his/her location to their guardian through SMS (Short Message Service).

In this project, we propose a newly design of spectacles for blindness people by using the existing smart vibration sensor system as the design of the system. The comfortability and convenience will be the main concern for this design.

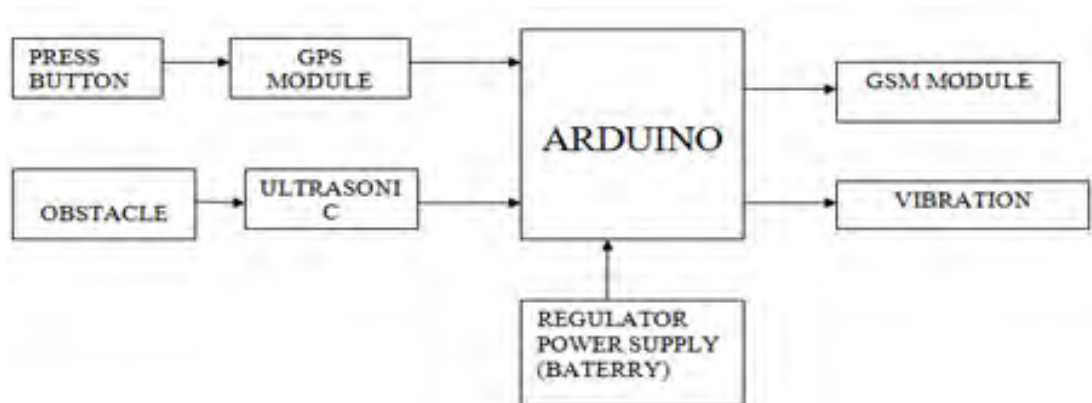


Figure 1.1: The Block Diagram of Smart Vibration System.

1.2 Problem Statement

The function of the smart vibration system is very useful for visually impaired people. However, the current design of the smart goggles doesn't fulfill the principles of ergonomic. In another word, it makes the user feel uncomfortable when wearing on it. The nose pads will bring health effect to users if the goggles are wearing for a long

duration as the goggle is large in size and heavy. Besides, the battery of the existing system (Rechargeable AA Battery) cannot support the system for a long duration. Most of the component or wiring of the system are also placed outside the goggles and this had definitely affected the appearance of the product. Furthermore, the size of the ultrasonic sensor on the goggles are heavy and large in size. More stress will apply on the user's nose and thus, cause uncomfortable to the user. In addition, the user is required to carry a big box which installs the GPS system and Arduino system during their walk.



Figure 1.2: Original design of smart vibration system

1.3 Objective

The general objective of this project is to increase satisfaction level on new design of smart vibration system ergonomically by:

- a) Minimize and simplify the component of the goggles while remain the functionality of the system
- b) Analyse the original design of goggles based on the comfortability by using RULA analysis.
- c) Prototyping and fabricating the product.

1.4 Prototyping and fabricating the productScope

In this project, the usability and comfortability is the main concern issues. Thus, the shape will be redesign according to ergonomics and materials will change to light materials. However, the function modification of the existing smart goggles will not be including in this project.

All the components in the system such as vibrator, sensor and battery will be simplifying together to obtain the smaller size of the goggles and maintain in light weight. Type of battery of the system will also upgrade to larger capacity while remain in smaller size and lighter weight so that the system can last longer after recharge while easy to carry. All the wires that expose outside the product which will affect exterior design will be combine as one wire to bring convenience and comfortability to users when wearing the goggles. For the ultrasonic sensor, the range finder system is cover from 0 to 0.8 meter. The rationale behind this is because ultrasonic sensor has better range detection compare to infrared sensor. The GSM and GPS inside the system also provide safety instruction to user as it can help to contact their guardians and Arduino is the core or master for this system as it controls the entire system in this project. The size of box that contain both Arduino, GSM and GPS in existing design will also be reduce to increase the portability.

The CAD software that choose for this project is SolidWorks. Analysis such as RULA analysis inside CATIA software will be done to test the sustainability of the redesign product.

CHAPTER 2

LITERATURE REVIEW

2.0 Overview

This chapter discuss all the summaries and reviews of the researches that related to this project.

2.1 Design

2.1.1 Product Design

To get more refine only as the design process moves toward its goal, highly involve, often ill-defined, complex and iterative process, and the needs and specifications of the required artifact are the important criteria inside the product design. An effective computer support tool that helps the designer make better-informed decisions that requires efficient knowledge to represent schemes. There is a virtual explosion in the amount of raw data available to the designer, and knowledge representation is critical in order to sift through this data and make sense of it in the world nowadays.

In order to shrunk product development time through the use of simultaneous and collaborative design processes, stay competitive is a must for a company. To

achieve these, effective transfer of knowledge between teams are important. Higher impact in terms of energy, cost, and sustainability are the awareness that need to pay attention on it when decisions are making early in the design process. It results in the need to project knowledge typically required in the later stages of design to the earlier stages (Chandrasegaran, et al., 2013).

However, Michael, K, and Mariëlle (2013) have different view on product design. They state that there are many important implications after products are manufactured. There remains a range of additional design decisions although the product is being developed. These additional design decisions include package design, also with those that are indirect consequences of earlier decisions, such as pricing. Customers' interest will be addressed in mass customization, willingness to pay, level of differentiation, and package design due to the research on product design's role in commercialization.

Alsyouf1, Al-Alami1 and Saidam (2015) have the same view that product design can be describe as a device to inspire innovation and altered the change of system. A continual and dynamic process which has no beginning and no end is used to describe the product design and improvement. Both products and processes are in a constant state of flux and a complex pathway which involves of feedback loops are followed by improvement process. Defining system requirements, as determined by stakeholders' needs (e.g. owners or operators, original equipment manufacturers (OEMs), service providers) should be done early in the conceptual design phase as this is a very important attempt effort when starting the product design and development. Some important criteria such as new environmental constraints, the constant mutation of the product, and to drive and realize such products and processes the continuous needs of specialist employees must be figure out and deal with it before a designer start the product design and improvement process.

2.1.2 Design Concept

According to Graening and Sendhoff (2014), design concepts can be used to define as an abstract representation of a class of designs sharing an analogous characteristic that map to approximately equivalent design qualities. Design concept must be generalizing from individual design solutions, the identification and representation of design concepts to classify designs with respects to shape and quality. It can lead to a structuring of the design domain, based on which design concepts can be used, the engineers will be supported by algorithmic identification of concepts when processing large amounts of design data.

Chiu and Salustri (2014) also have similar view that the term design concept is often used. In fact, it only several definitions provided. Despite the desultory definition for concept, the design process is usually more rely to concepts. For example, brainstorming and generating multiple design concepts, and subsequently identifying design concepts for concept selection, evaluation and development, etc. As concepts play a central role in human cognition, concepts and concept formation are of particular interest in psychology. Interest in other fields such as archaeology, bioinformatics and education are also including as one of the concepts and concept identification.

2.1.3 Design Problem

Tong and Sriram (cited in Chandrasegaran et al., 2013) states that design can be describing as a process that meets certain performance criteria and resource limitations by constructing a description of an artifact, process, or instrument that satisfies a (possibly informal) functional specification. It is realizable, and satisfies to certain criteria such as simplicity, testability, manufacturability, and reusability. In the other hand, design can also be differentiating as a process that involves mapping a specify function onto a realizable physical structure. It is found that mapping between function and structure is often complex. A complex organization of a large number of