REALIZATION OF A WORKING PROTOTYPE OF WEARABLE-CHAIR

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REALIZATION OF A WORKING PROTOTYPE OF WEARABLE-CHAIR

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A report submitted
in fulfillment of the requirements for the degree of
Bachelor of Mechanical Engineering with Honours

Fakulti Kejuruteraan Mekanikal

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2019

DECLARATION

I declared that this project report entitled “Realization of A Working Prototype of Wearable-Chair” is a result of my own work except as cited in the reference.

Signature : .....…….....

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Date : .....……..….

APPROVAL

I hereby declare that I have read this project and in my opinion this report is sufficient in terms of scope and the quality of the award of the degree of Bachelor of Mechanical Engineering.

Signature : .....…….....

Supervisor's Name : Dr. Shamsul Anuar Bin Shamsudin

Date : .....……..….

DEDICATION

I dedicate this report to my beloved family, lecturers and dearest friends

ABSTRACT

Declining health rate among the factory workers is worrisome. Some of the reason is due to overwork that could cause back pain, headache, muscle fatigue and more. Thus, to overcome the muscle fatigue problem, chairless chair or wearable-chair has been invented. This device lets the user to sit on it anytime and everywhere by equipping the device on the users' legs. The purpose of this study is to develop and realize the new design of the chairless chair by implementing methods and techniques of mechanical engineering design and manufacturing process. Before furthering to 3D model development, a survey is done among factory workers, doctors and lecturers to get valuable data for this project. From the data, a House of Quality was used to determine the engineering details for the product also the important technical details to be prioritized in the design. From the House of Quality data, few conceptual designs were made and evaluated to obtain the final design. The final design is then modeled by using SolidWorks. To determine the functionality of the 3D model, two analyses were conducted. The first one was a motion study analysis. This analysis was conducted to observe the motion of the model if it were to put in the actual situation where the gravity and extra forces took place. The second one was stress analysis. The purpose of this analysis was to determine the endurance of the product and to define the critical stress area so that improvements can be made in the design to achieve a factor of safety of more than one for the whole model. Then, further manufacturing processes were discussed.

ABSTRAK

Penurunan kadar kesihatan dalam kalangan pekerja kilang adalah merisaukan. Antara penyebabnya adalah bekerja keras yang boleh mengakibatkan sakit belakang, sakit kepala, keletihan otot dan sebagainya. Untuk mengatasi masalah keletihan otot, "chairless chair" ataupun "wearable-chair" telah pun diinovasi. Alat ini membolehkan penggunanya untuk duduk pada bila-bila masa dan dimana-mana sahaja dengan memakainya di kaki pengguna. Tujuan kajian ini dijalankan adalah untuk membina dan mewujudkan sebuah rekabentuk yang baharu dengan menggunakan kaedah dan teknik rekabentuk kejeruteraan mekanikal dan proses pembuatan. Sebelum melanjutkan pada merekabentuk model 3D, sebuah kajian soal selidik telah dilakukan dalam kalangan pekerja kilang, doktor dan pensyarah untuk mendapatkan data yang berguna untuk projek ini. Daripada data tersebut, sebuah "House of Quality" dilakukan untuk mengenalpasti butiran kejuruteraan untuk produk dan juga butiran teknikal yang penting untuk diutamakan dalam rekabentuk ini. Daripada "House of Quality", beberapa konsep rekabentuk dihasilkan dan dinilai menggunakan "Weighted Decision Matrix" untuk mendapatkan rekabentuk konsep akhir. Rekabentuk konsep akhir ini kemudianya dimodelkan menggunakan Solidwork. Untuk menentukan keberfungsian model 3D tersebut, dua analisis telah dilakukan. Yang pertama adalah "motion study analysis". Analisis ini adalah untuk melihat pergerakan model dalam situasi sebenar dimana daya graviti dan daya tambahan berlaku. Yang kedua adalah "stress analysis". Tujuan analisis ini adalah untuk menentukan ketahanan produk dan untuk menentukan kawasan stress yang kritikal supaya pembaikpulihan dapat dilakukan pada rekabentuk untuk mendapatkan "factor of safety" lebih daripada satu untuk keseluruhan model. Kemudian, proses pembuatan dibincangkan.

ACKNOWLEDGEMENTS

My deep gratitude goes first to my supervisor Dr. Shamsul Anuar Bin Shamsudin from Faculty of Mechanical Engineering, University Technical Malaysia for his supervision, ideas, advice, support and encouragement towards the completion of this project.

My appreciation also extends to this project second examiner, En. Juffrizal Bin Karjanto, also from Faculty of Mechanical Engineering, University Technical Malaysia for the guidance that has been given to produce a good report.

Special thanks to my family, especially my mother. I am indebted to my mother, Puan Jamaliah Binti Md Noor for her persistence in raising me to be a successful person and for the love that has no end of it.

Also, to my dearest friends for the huge moral support throughout my study here. And not to be forgotten, to all university staffs that were always helpful when I needed it.

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CHAPTER 1

INTRODUCTION

1.1 Background

Wearable-chair is one of the genius inventions in world history. There are not many wearable-chair designs in the current market. The companies involved in the invention of this device are from Swiss, Japan and a few European countries.

The world's first chairless chair was designed by the Swiss studio Sapetti and developed by Noonee in Zurich in 2014. "The idea came from wanting to sit anywhere and everywhere, and from working in a UK packaging factory when I was 17," says Keith Gunura, the 29-year old, CEO and co-founder of Noonee (Jacopo, 2018).

Figure 1.1: Chairless chair designed by Sapetti (Stinson, 2018)

It has a bold design of exoskeleton. It can also be carried anywhere and designed for the workers to be able to walk normally and can sit wherever they wanted to and adjustable

to suit with the user's height (Baba-Mail, 2018). It has a push button to lock the frame at the desired angle, and the device will not touch the ground unless in a static position. It has a belt and also wraps to tie the device with legs (Jacopo, 2018). But, it is not an easy task to design for ergonomics and let the users move freely when using the chairless chair.

Another design is the Archelis, which means walk-able chair in Japanese. The main objective of making the Archelis is to help the medical surgeon and industry workers to overcome fatigue from long hours of standing. It is totally designed and manufactured in Japan (En.wikipedia.org, 2018).

Figure 1.2: The Archelis wearable-chair (Nikkei Asian Review, 2018)

Not only Noone and The Archelis invented chairless chair, but there is also a simpler design, Ofrees (See Figure 1.3) which priced at more than USD 950 per item (Aouf, R, 2018).

Figure 1.3: Ofrees wearable-chair (Aouf, R, 2018)

The main reason why all chairless chairs were invented is to reduce time standing for industry workers also able to prevent back pain thus improve workers health. Other reason would be to eliminate the use of conventional chairs in a workplace in order to have more space.

1.2 Problem Statement

Wearable-chair is less practicable in Malaysia because of a few reasons. The main reason is the price. The price of one chairless chair with the least attractive design is more than USD 950. The designs that using titanium as its frame material and hydraulic piston powered are expensive. Another reason is, all products are manufactured in European countries and Japan makes it more expensive. Other than that, there are components inside the wearable-chair that are consuming energy from the battery, this is considered as less environmentally friendly because some batteries are non-rechargeable. Most of the current chairless chairs have a large belt to secure around the waist. This size of the belt is not comfortable to use because it traps heat and blocks body movements.

1.3 Objectives

The objectives of this project are:

i. To design a wearable-chair that meets customer needs using computer-aided design (CAD) software.

ii. To do motion study and stress analysis on the wearable-chair design using CAD software.

iii. To manufacture a working prototype of the wearable-chair.

1.4 Scope

The scopes of this project are:

i. Obtaining customer requirements on safety, appearance, materials and more for wearable-chair.

ii. Use a proper design tool to translate customer needs into engineering properties.

iii. Developing conceptual designs using concept generation method and make concept evaluation and selection to choose the best conceptual design.

iv. Developing a 3D design of the final conceptual design by using CAD software.

v. Simulating the stress analysis and motion analysis.

vi. Building a prototype based on the final conceptual design using appropriate tools and techniques.

vii. Testing the prototype.

viii. Writing a full project report.

CHAPTER 2

LITERATURE REVIEW

2.1 The Archelis Wearable-Chair

The Archelis in Figure 2.1 was designed by Yokohama-based mold factory, Nitto, along with Chiba University's Center for Frontier Medical Engineering, Hiroaki Nishimura Design, and Japan Polymer Technology (En.wikipedia.org, 2018).

Figure 2.1: The Archelis (Source: Google Image)

Their aim is to help surgeons. There are surgeries that take more than 5 hours to complete, for example, laparoscopy. Long hours of surgeries cause muscle fatigue on the surgeon. Also, the operation table is high that it leads to the same problem (En.wikipedia.org, 2018).

This device does not use electric, made of carbon segments and materialize with hook and loop closure it is safe to use in the surgery room. This device parts such as thigh and shin are adjustable and flexible makes it comfortable to use for long hours of usage. Its size is 78x40x30cm and weighs up to 5kg (Digital Trends, 2018). It has straps that cover wearer legs and buttocks and also cushion that acts as supports on shin and thigh (Nikkei Asian Review, 2018).

In 2015, the company had improved the device's stretchy belts and become more reliable as the users can change sitting position on their own. They did this by partnering with Chiba University's Center for Frontier Medical Engineering to create technology to make equipment to fit human bodies (Digital Trends, 2018).

2.2 Noone Chairless Chair

Noone chairless chair (Figure 2.2) was first designed by Swiss studio Sapetti and it is designed primarily for manufacturing environments, where workers are required to stand for long periods of time and allows its wearer to sit down whenever and wherever they need to (Baba-Mail, 2018). The Chairless Chair Noone chairless chair are sold directly to businesses for their staff use including training on how to operate it (Newatlas.com, 2018).

Figure 2.2: Noone Chairless Chair (Newatlas.com, 2018)

Noonee Chairless Chair is an effective way to help decrease physical strain and increase productivity. It has waist belt stirrup and thigh straps. The user will position himself and adjust the switchable lock to lock the device position to sit on it. It uses hydraulic powered to support user weight. This exoskeleton device can be instant support when user bending, crouching or squatting (Baba-Mail, 2018).

It is mostly made of lightweight and durable engineering plastic, polyamide, weighs around 3.4 kg (Newatlas.com, 2018). This newest Noone chairless chair has lesser weight and more aesthetic compared to its previous version. It suits people of different heights, body size, and can be fitted to any kind of safe-footwear (Baba-Mail, 2018).

2.3 Ofrees Wearable-Chair

Ofrees wearable-chair is a foldable chair (See Figure 2.3). The main frame is made from aluminum 7075, the material has excellent durability lightweight, and has tensile strength almost equal to iron. The wearable-chair uses an alloy in the form of zinc as its main material (Aouf, R, 2018).

Figure 2.3: Ofrees wearable-chair folding picture (Aouf, R, 2018)

Ofrees is pre-install. The equipment shown in Figure 2.4 are rubbercap, gaiter, mainframe, backpack, and waistbelt. The mainframe is foldable, and it can be folded into two, then put it in a backpack to carry around.

Ofrees design is genius, only the mainframe is made of metal, and the rest are made of fabric and small components (Aouf, R, 2018). This makes it easier to be folded and to fit in a backpack. Also, to make this small mainframe strong, they use a strong material that as strong as iron but lighter so that it is easy to be carried.

Figure 2.4: Ofrees wearable-chair equipment (Aouf, R, 2018)

This design comes in many sizes, S to 2XL, S is for a person with 145cm tall up until 154cm, 2XL is for 183cm tall and above (Aouf, R, 2018). It uses velcro on both gaiter and waistbelt makes it easier to equip. These two components wrap wearer's waist, shin and calf to provide more comfort while wearing it. Figure 2.5 below shows a front, side and rear view of a person wearing Ofrees wearable-chair.

Figure 2.5: Ofrees wearable-chair on a person (Ofrees.com, 2018)

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describes the methodology used in this project to develop a detailed design of the chairless chair. The flowchart of the project is shown in Figure 3.1 This project is started by studying the recent models available in the market. After the engineering characteristics of the models have been identified, the survey is conducted to obtain the customer requirements. From survey analysis, the project is proceeded with the House of Quality (HOQ) to define the important characteristics. Then, proceed with the concept generation process and concept selection. Lastly, the detailed design of the product is reported.

3.2 General Processes

Project flowchart is developed to ensure the smooth running of the project by arranging each process accordingly. There are 13 processes involved in this project based on Figure 3.1. The processes include in the project flowchart are listed and explained as below;

1. Title registration

   Students are required to choose and register their title in psmonlinesystem.net website.