Faculty of Applied and Creative Arts

MECHANICAL ASSISTIVE HAND FOR *SYMBRACHYDACTYLY* PATIENTS

Ooi Shin Ying

Bachelor of Applied Arts with Honours
(Design Technology)
2017

MECHANICAL ASSISTIVE HAND FOR SYMBRACHYDACTYLY PATIENTS

OOI SHIN YING

This project is submitted in partial fulfillment of
the requirement of the degree of Bachelor of Applied Arts with Honours
(Design Technology)

Faculty of Applied and Creative Arts
UNIVERSITI MALAYSIA SARAWAK
2017

ACKNOWLEDGEMENT

I would like to take this opportunity to express my profound gratitude to Dr. Faridah binti Sahari for willing to be my supervisor in Final Year Project (FYP). The guidance, advises, encouragements and blessing from her have became my motivation to move forward.

Secondly, I would also want to thank Dr. Saiful Bahari Mohd Yusoff, Dr. Musdi bin Hj. Shanat, Madam Maizatul Nurhuda binti Saadon and Mr. Muhyiddin bin Mohammed for giving their professional suggestions to me in my FYP.

I am obliged to manager of Pebblereka Company, Mr. Ahmad Hilmi bin Muhammad and 3D printing expert, Mr. Sujana Mohd Rejab as well as the Dean of Faculty of Medicine and Health Sciences (FMHS), Professor Dr. Ahmad Hata bin Rasit who masters in orthopaedic field for providing their knowledges and experiences to me throughout interview.

I would also like to express my gratitude to my parents and friends who always give me mentally support along the way. Their supports have definitely make me stronger to fight for my FYP.

Without them all, I might not able to complete my FYP and proudly entered the CIPTA (Cetusan Inspirasi Pelajar Tahun Akhir).

Lastly, I do hope that my research able to help *symbrachydactyly* patients from around the world.

TABLE OF CONTENT

ABSTRACT

The existing mechanical hand product in the current market are not applicable for *symbrachydactyly* patients in the aspects of holding objects and interact with touch screen technology. The 3D printing error that causes users to reprint again has brought them financial burden. Therefore, this research is aimed to provide solutions for *symbrachydactyly* patients which based on the related existing problems. The design will mainly focus on gripping problem by designing an ergonomic aid product through the product validation and analysing the existing products in the market as well as identifying their gripping capacity and obstacles in the condition of with and without aid products. This research will be conducted by collecting the data through the method of interview and reading related information from secondary data. The result will then be used to improve the gripping ability and interaction with current technology as well as solving printing error problem. This is to ensure the *symbrachydactyly* patients to have normal life as other people do.

ABSTRAK

Pada masa kini, produk sedia ada untuk pesakit symbrachydactyly adalah kurang efektif dalam aspek pemegangan dan interaksi dengan teknologi skrin sentuh. Masalah dari mesin bercetak 3D telah membawa beban kewangan kepada pengguna kerana terpaksa untuk mencetak produk semula. Oleh itu, kajian ini bertujuan untuk menyelesai masalah pemegangan pesakit symbrachydactyly dengan menentukan rekaan peralatan bantuan yang ergonomik melalui analisis produk sedia ada di pasaran serta kebolehan mereka dalam aspek tahap pemegangan dan kekangannya dengan kewujudan serta tanpa kewujudan peralatan bantuan. Keputusan rekaan kajian ini akan divalidasi oleh pesakit berkaitan kemudian. Kajian ini akan dijalankan dengan mengumpul data melalui kaedah temu bual dan membaca informasi berkaitan dari data sekunder. Keputusan kajian akan diguna untuk meningkatkan keupayaan dalam pemegangan dan interaksi dengan teknologi semasa serta masalah dari mesin bercetak 3D. Kajian ini adalah untuk mengenal pasti pesakit symbrachydactyly untuk mempunyai kehidupan normal seperti orang lain.

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ABBREVIATIONS

TSRH	: Texas Scottish Rite Hospital
3D	: Three dimensional
PLA	: Polylactide
ABS	: Acrylonitrile butadiene styrene
TPU	: Thermoplastic polyurethane
STL	: STereo Lithography
PDS	: Product design specifications
SWOT	: Strengths, Weaknesses, Opportunities, Threats

CHAPTER ONE

INTRODUCTION

1.0 Introduction

Congenital hand disorder can be sorted into different types, which are adactyly, cleft hand, polydactyly, syndactyly, thumb deficiency, ulnar deficiency, webbed fingers as well as *symbrachydactyly*.

Symbrachydactyly is congenital hand disorder which occurred during fourth to sixth weeks of pregnancy and possibly caused by insufficient blood supply to the hand during pregnancy (Panossian, 2015). It happens to proximately 30,000 to 40,000 babies in every year, which can range from minor finger anomalies to completely missing fingers. There are four types of *symbrachydactyly*, which are short finger, central deficiency (cleft), *monodactylous* (thumb) and *peromelic* (adatylous).

Based on the reviews, *symbrachydactyly* patients will face the problem of gripping and feeling inferior due to their physically different with other people, especially to children. The ways to cure this problem are through surgery or assistive equipment (Seattle's Children Hospital, n.d.). There are few products in the market which customize for *symbrachydactyly* patients. However, they are not suitable enough to assist *symbrachydactyly* patients in their daily life due to several restrictions.

Therefore, this research will be carried out to solve their limitations. Several solutions such like enhance their gripping ability and interaction with technology device features are under the consideration in this study.

1.1 Background of the Study

Symbrachydactyly refers to people who born with congenital hand disorder which they have missing fingers or short fingers as nubbins. The factors of this non-genetic inherit defection remain unknown (Texas Scottish Rite Hospital, n.d.). This occurs during the mid-fourth week to eighth week of pregnancy when the embryo starts developing the upper limbs (Ahmad Hata Rasit, 2016). During this period, the insufficient of tissues to build up the fingers structure are then causing deficiency on fingers.

Generally, this deficiency takes place on one hand of the patients which another hand born in normal structure (TSRH, n.d.). This allows them to do their daily activities with the present of one normal hand. However, the flaw of their another hand becomes a burden to them especially in the situation that involves both hands. For instance, tightening a piece of string. Without the present of another normal hand, it is hard for them to hold the ends of string and bind up both side together.

Due to the increasing number of *symbrachydactyly* cases, many organizations are then created to provide a platform to assist people. Most of the organizations are mainly made up from parents who their children born with *symbrachydactyly* or experts who able to provide solutions to them. These can be traced through the websites such as Lucky Fin Project, The Aussie Hands Foundation Inc and Limbskids Support Association Inc while the solutions for *symbrachydactyly* are from Enabling the Future, Advanced Arm Dynamics and Touch Bionics (Lucky Fin Project, n.d.).

There are few solutions such as surgery or prosthetic hand in electronic nor printed forms to assist *symbrachydactyly* patients in different way. However, it does not mean that it is applicable to all *symbrachydactyly* patients in term of the structure,

cost and features. Meanwhile, not all people able to afford the high price to cure their deficiency through surgery or purchasing an electronic hand. Consequently, most of them prefer to obtain printed prosthetic hand to replace their incomplete finger structure. Regardless of the affordable price of printed prosthetic hand, it has limitation on features.

Therefore, this research is undertaking to solve those problems by applying 3D printing technology.

1.2 Problem Statements

A person with *symbrachydactyly* will be different to others in physically. The form of their hands that has not fully developed during the fourth or sixth week of pregnancy has brought them problems in daily life.

Normally, public will categorize them as disabled persons even though they can handle their life properly. The public's negative perception to a person with physically difference has caused anxiety to their parents (Landrygan, 2014). Eventually, this will indirectly affect the feeling of their parents in negative way.

Fingers act as a gripping tool for people to carry an object. Gripping object is an easy task to all people but not to the people who born with *symbrachydactyly*. People who born with *symbrachydactyly* do not have proper gripping skill as their fingers are not fully developed. They cannot bend down their fingers to hold something as their fingers are too tiny and has no bone to support an object.

Even though there are several existing products for *symbrachydactyly* patients, yet it cannot fully fulfil the needs of *symbrachydactyly* patients due to its limitation to hold small objects. Thus, this study is aimed to enhance the gripping force of *symbrachydactyly* patients without applying much strength on bending wrist as well as to avoid printing errors on the product.

1.3 Research Questions

This research covers several questions:

i. What is the suitable aid product design for *symbrachydactyly* patients?
ii. How the design helps them in daily life?
iii. What is their essential needs in daily life?
iv. What is the capacity of the existing aid product?
v. What is the limitation of *symbrachydactyly* patients in daily activities?

1.4 Objective of the Study

There are four objectives to be achieved at the end of the study:

i. To identify the existing aid products in the market.
ii. To investigate their hand gripping capacity and obstacles with and without aid products.
iii. To design ergonomic aid product for *symbrachydactyly* patients.
iv. To validate the product design on *symbrachydactyly* patients.

1.5 Scope of the Study

This research will be carried out in Pebblereka Company which located in Subang Jaya, Kuala Lumpur, a 3D printing company which has involved on printing assistive product for *symbrachydactyly* patients. An interview would be conducted to this company's manager, Mr. Ahmad Hilmi bin Muhammad. This interview composes several questions which focus on the way to create a printed prosthetic hand as well as it's improvements for *symbrachydactyly* patients.

An interview to an 3D printed prosthetic hands expert will also be conducted through phone call. This is to understand the problems of existing products and suggestions of improvements on existing products. The result from this interview will be under the consideration on designing the final product.

Apart from that, this research will also involve on interviewing an orthopaedic doctor, which is also a dean for Faculty of Medicine and Health Sciences in the Universiti Malaysia Sarawak (UNIMAS), Professor Dr. Ahmad Hata bin Rasit. This interview is important to collect the professional suggestions on the product design to ensure what is the best for *symbrachydactyly* patients.

The outcome of the product design will be validated on the *symbrachydactyly* patients. This is to make sure the result of the design achieves the objectives of this research. The purpose of this validation is also to identify the ability of the product.

1.6 Significances of the Study

Symbrachydactyly is a kind of congenital hand which in the other mean is fingerless. People that born with *symbrachydactyly* could not hold an object welly as their fingers structure is not able to grab an object.

The awareness of *symbrachydactyly* in Malaysia is still at early stage. Public is not aware on this issue, which then automatically labelled *symbrachydactyly* patients as disabled people that only have limited working ability to perform task. Thus, the perspective from most people to *symbrachydactyly* as disorder has indirectly hurt the feeling of *symbrachydactyly* patient as well as to their family.

Aside from that, the existing products in the market are not suitable for *symbrachydactyly* patient as most of the design of products require users to bend down their wrist when they want to hold an object. Day by day, this causes their wrist easily to get injured due to repeating the same position in daily life. The existing products which have their own limitation on holding small objects due to its structure design and material preferences. The existing mechanical hands also have become the obstacles for them on interaction with the touch screen technology limit them in daily activities.

Therefore, this research has to be carried out in order to solve the gripping problem of *symbrachydactyly* patients as well as interaction with touch screen technology. This is to ensure the *symbrachydactyly* patients to proceed their life as normal people do without any constraint and limitation.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The word of *symbrachydactyly* or short joined hand is a Greek word where the "syn" means joined, "brachy" means of short while "dactyly" means finger (Lucky Fin Project, n.d). Normally it happens on one hand of a person only. There are four types of *symbrachydactyly*, which are short finger, cleft hand, *monodactylous* and *peromelic*.

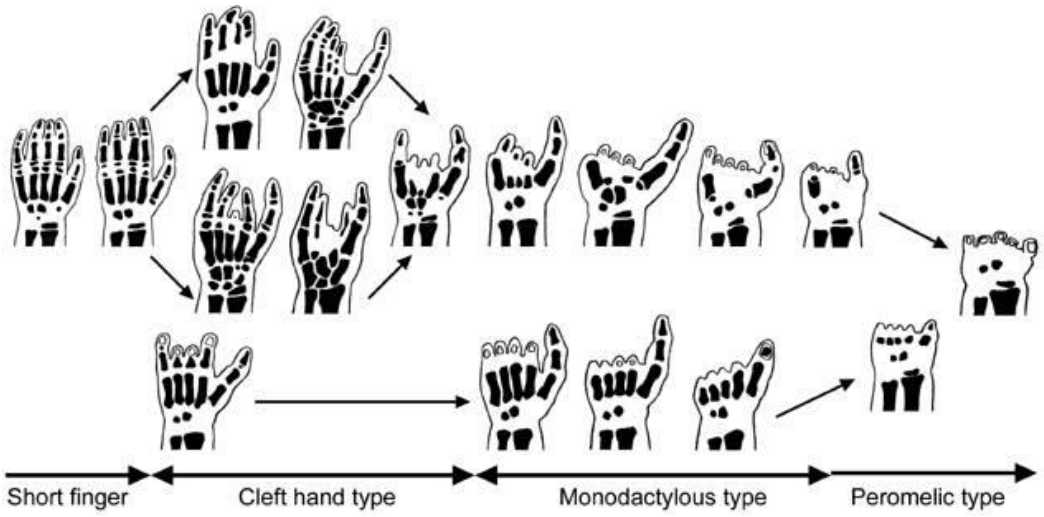

Figure 2.1: Types of *Symbrachydactyly*.

(Source: Lucky Fin Project, 2014)

2.1 Types of Symbrachydactyly

2.1.1 Short Finger Type

There are two types of short finger, which are *syndactyly* and *brachydactyly*. *Syndactyly*, or the fusion of fingers is result when fingers failed to separate in utero during birth. This caused the skin of fingers to join or sometimes to the bone, tendons,

nerves or blood vessels of fingers. Some forms of *syndactyly* may not need treatment but to those who required operation, web spaces would be create carefully to minimize scarring (Scottish Rite Hospital, n.d). After the forming of space between fingers, skin graft which is the skin from another part of body is needed as a medium to cover the space between the fingers.

While *brachydactyly* is a condition where all the fingers grow shortly. This would not affect the function of hand but to the appearance of hands. This means that surgery is not usually required. According to the research by Goldfarb (2013), the percentage of heritability of *symbrachydactyly* is 50%.

2.1.2 Cleft Hand Type

Cleft hand, or central deficiency is a condition where thumb and small finger present, which causing the middle side of hand palm becomes V-shape. This kind of congenital anomaly are involved in the appearance and function of hand issues. In the other mean, this deficiency is notable in appearance as well as to the impact of hand which cannot function well when compared to normal hand. This is because of the weakness of hand that caused by the missing bone, intrinsic muscle (a muscle to straightening of fingers), tendon and ligaments. It literally limits the main function of hand, which to hold an object. Therefore, a surgery which involves the removal of extra skin between the fingers and tightening the space between the index finger and ring finger is required in order to improve the gripping function of hand (Goldfarb, 2013).

2.1.3 Peromelic Type

Peromelic, or *adatylous* is occurred when only wrist bones are present instead of the fingers. This kind of congenital can related to the Poland syndrome (partial breast muscle absence) (Goldfarb, 2013). It is difficult to reconstruct the fingers form due to lack of proximal structures (Richards & Dafydd, 2014). It caused the limitation of the function of hand since the length of fingers is not long enough to grab an object.

2.1.4 Monodactylous Type

Monodactyly occurred when only one digit of finger, which is thumb present and other fingers would appear as nubbins. It is almost under the same situation with *peromelic* type but with the addition thumb appears only. Due to the condition of narrow space among fingers, hygiene is always a min issue to be connected as the dirt would get into the space between fingers easily, yet it would hard to be cleaned up. After a long time, the skin would get irritated due to the frequency on removing dirt. Even though those nubbins would be a burden to patient, but most of them choose to not remove it (Goldfard, 2014).

2.2 Existing products

Gripping objects is a tough job for a *symbrachydactyly* patient as fingers are the part of body which function as a gripping tool. Thus, E-Nable Community has created out many designs of three dimensional printable hands, which in the other mean is a “metal hands”. The design would be reassembled hands which allow patient

to do daily task by using those “fingers”. Hence, they have improved the design of this products by renovation the product to improve the functions as well as according to the ergonomic term that allows users to use it with comfortable. They will provide the data of three dimension design to public so that people from other countries can create one by just downloading it and print it out thru 3D printer. (Enabling the Future, n.d)

The types of hand design that they offered can be sorted out into eight types, which are:

2.2.1 Raptor Hand

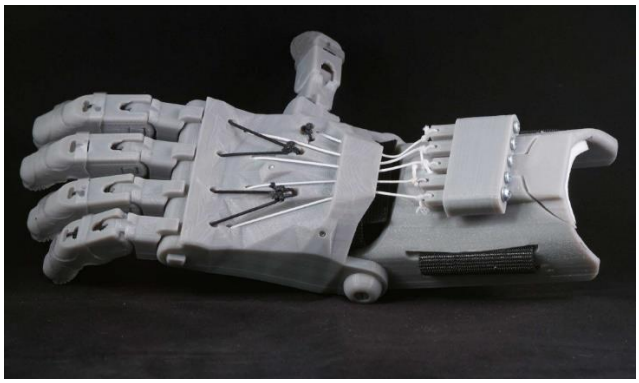

Figure 2.2: The design of Raptor Hand.

(Source: Simon, 2014)

This design is a redesign product whereby new features have been added on. The highlights of this design are it takes less efforts and less time to print it out, which there is no support needed on printing out. Meanwhile, less extra structures are required to print out in order to support the other printing parts. Besides that, this design is much simple. Therefore, people can assemble easily. This design has also improved the gripping mechanism, which allows symbrachydactyly patients to hold things with more tightly.