UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND ANALYSIS OF HAND AND WRIST SUPPORT DEVICE

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

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APPROVAL

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

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ABSTRAK

Tujuan projek ini adalah untuk mereka bentuk alat sokongan tangan dan pergelangan tangan dengan menggunakan Kejuruteraan Songsang (RE) kaedah dan Additive Pembuatan (AM) proses. Matlamat projek ini adalah untuk menghasilkan alat sokongan tangan dan pergelangan tangan dengan meningkatkan ergonomik dan selesa kepada pesakit. Projek ini memberi tumpuan kepada reka bentuk prototaip alat sokongan tangan dan pergelangan tangan berdasarkan geometri tangan dan pergelangan tangan pesakit dan jenis kecederaan yang dialami. Kebanyakannya, alat-alat sokongan yang sedia ada untuk tangan dan pergelangan tangan terutama bagi pesakit yang mengalami kecederaan yang teruk seperti patah tulang atau retak mempunyai saiz standard mengikut umur mereka. Tetapi apabila mengalami kecederaan yang teruk seperti patah tangan masih lagi menggunakan "plaster of paris" yang mana menyukarkan pergerakan dalam membuat sesuatu perkara. Walau bagaimanapun, pengguna akan berasa tidak selesa. Satu tinjauan awal telah dijalankan melalui soal selidik untuk tindak balas awal sokongan peranti pada tangan dan pergelangan tangan. Perisian boleh memudahkan data dan merekabentuk semula tangan dan pergelangan tangan perlu digunakan dan sebahagian daripada perisian adalah Geomagic Studio 10 dan Solidwork 2013. Untuk proses imbasan, Faro Arm digunakan untuk mendapatkan bentuk tangan menggunakan patung palsu dan bentuk tangan yang diperbuat daripada lilin. Kemudian peranti sokongan tangan dan pergelangan tangan yang telah dihasilkan oleh Solidwork akan dihantar kepada Pemodelan Endapan Terlakur (FDM) mesin untuk menghasilkan prototaip. Proses seterusnya adalah melukis keperluan untuk dianalisis menggunakan simulasi

Solidwork, keputusan analisis menunjukkan bahawa tekanan rekabentuk tangan dan pergelangan tangan sokongan yang dihasilkan oleh FDM adalah selamat untuk digunakan berdasarkan faktor keselamatan adalah lebih tinggi daripada 1.

ABSTRACT

The purpose of this project is to design a hand and wrist support device by using Reverse Engineering (RE) methods and Additive Manufacturing (AM) process . The goal of this project is to produce hand and wrist support device to improve ergonomics and comfort to patients. This project focuses on the design of a prototype tool based on the geometry of the hand and wrist support for patients and types of injuries sustained. Mostly, the tools available to support the hand and wrist , especially for patients suffering from severe injuries such as fractures or cracks have standard size according to their age but when suffering severe injuries such as fracture hand and wrist still using plaster of paris which makes it difficult for the movement to make a thing . However, users will feel uncomfortable. An initial survey was conducted through a questionnaire for early response on hand and wrist support device. Software with can facilitate data and redesign the hand and wrist support device need to used and some of them are Geomagic Studio 10 software and Solidwork 2013. For the scanning process, Faro Arm is used to get hand shapes using fake statue and hand shape made of hand wax. Then the hand and wrist support device that has been produced by Solidwork will be sent to the Fused Deposition Modeling (FDM) machine to produce a prototype. The next process is drawing need to analyzed using Solidwork simulation, the results of the analysis indicate that the design pressure of the hand and wrist support FDM produced parts are safe to use based on the safety factor is higher than 1.

DEDICATION

I dedicate this project to my family, friends and lecturers. I am able to accomplish the goals and objectives of this project is all thanks to everyone for the time and knowledge they have given me throughout the project.

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I would like to thank my supervisor Dr. Shajahan Bin Maidin, for guiding me along the way from the beginning of this project. I also would like to say thank you to my fellow classmates and friends for helping me in perform various work day and night. Lastly I want to give my deepest gratitude to the university for giving me the opportunity to undergo this subject which has helped me greatly in gaining better insight on the vast world of design and development. This project has helped to grow into a better person with better experience.

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LIST OF ABBREVIATTION, SYMBOL, AND NOMENCLATURE

AM	Additive Manufacturing
BPM	Ballistic particle manufacturing
BASS	Break Away Support System
CAD	Computer aided design
CAM	Computer aided manufacturing
DMD	Direct Metal Deposition
FEA	Finite Element Analysis
FDM	Fused Deposition Modeling
HOQ	House of quality
LOM	Laminated object manufacturing
PLT	Pares lamination Technology
MJM	Multi-Jet Modeling System
QFD	Quality function development
RE	Reverse engineering
STL	Stereolitography
SLS	Selective laser sintering
SGC	Solid ground curing
3DP	Three Dimensional Printing
SDM	shaped deposition manufacturing
VOC	Voice of customer
μ	Micro

CHAPTER 1

INTRODUCTION

1.1 Background of research

Additive manufacturing is defined and refer ability to produce a layer by layer fabrication of three-dimensional physical model prototttype or whether the actual product by directly or indirectly from computer-aided design (CAD). This help and engineers and designers to print up their ideas in three dimensions (Kenneth ,2002,p1). Additive manufacturing is one of the rapidly increasing use of alternative because of their capacity to produce alternative faster and cheaper to produce prototypes and working models compared to the conventional route that requires a lot of process to produce the output. (Kenneth, 2002,p1).

Haughton et al (2012) described fracture is caused by soft tissue injury involving bone-related injuries. According to Haughton et al.(2012), hand fracture is a very common fractures encountered in either accident and emergency department and in orthopedic clinics. Statistic based on emedicinehealth.com, hand injuries account for nearly 10% of hospital emergency department. Out of 1000 consecutive hand injuries showed the following distribution: It shows that 42% of lesions (lesions), 27% contusions (bruises), fractures of 17% (broken bone), and 5% of infections. Hand injuries

account for about 17% of all lost workday injuries. The most common causes of hand injuries involve blunt trauma resulting from a 50% followed by injuries from sharp objects. Another statistic at below showed the hand fracture in Southern Asia.

Type of fracture	Number	*Percentage*
Fingertip fractures	92	*20.3*
Epiphysial fractures	130	*28.7*
Shaft fractures	109	*24*
Joint fractures	84	*18.5*
Comminuted fractures	39	*8.6*
Total	454	*100*

Figure 1.1: Classification of fractures of the phalanges (Barton, 1984)

Based on Figure 1.1, it shows that the classification phalanges fracture. Although this statistic just cover fractures of the phalanges but for this statistical it show that it need to design a new splint to change previous treatment for hand and wrist fracture from using cast to another product that easy to install.

Design for fracture hand and wrist need to present additive manufacturing as reference to get a good result for heal support for frature hand or wrist. This is due to the additive manufacturing can produce or develop products to start producing very thin cross sections or simply called layer by layer, one above another, until solid physical part completed. (Kenneth, 2002,p1). Other advantages that can be with additive manufacturing, because it can be used in the manufacture of products based medicine, it is also able to create form complex shapes that are nearly impossible to make using the machine, and can build an internal structure, and even its ability to produce features a very thin wall (Kenneth, 2002,p1).

Important thing that need to consider is an ergonomic and make a product is ease to use and fitting. Based on Silverstein and Clark (2004), Ergonomic will help a patient or human in two ways: by design an appropriate task and equipment, it can avoid strainful body exertions and by using suitable body structure. So, it is important to design a good splint to reduce stress for hand and wrist and help patient to heal as soon as possible.

1.2 Introduction

According to Matthews (2012), the most common ailments that facing athletes is injuries to the hand and wrist. This is an example of pain that happend such as hand fracture. Hand have made up of bones called phalanges and metacarpals. Bones of the fingers is called phalanges and bones that make up your knuckles and connect to your wrist. Figure 1.2 show the example of hand and wrist bones.

Figure 1.2: Example of hand wrist bones

(Source :< http://www.drugs.com/cg/hand-fracture-discharge-care.html> 01/10/13)

Hand are common injuries that affect specialist athletes and common people when get involved with an accident. It can also be classified into two main categories: traumatic (acute) and overuse (chronic) (Matthews,2012). Traumatic usually occur for athletes that participate in footbll, hockey or wrestling and for overuse usually occur for athletes that participate in baseball, tennis or golf (Matthews ,2012).

The are two types of supporting device available in market to support hand or wrist fracture cast and splint. Because of different ages and body sizes, surface of the device not completely close to hand or wrist. When using cast, cast need to cover with plastic back to prevent cast for an infection. Among the important factors and should be considered is the material and ergonomic. It is use in the production of the device because it is sufficient to give effect to the hand and wrist as a supoort for the hand and as a device for healing.

So, to make supporting device, research must be focused on ergonomic with an analysis using SolidWork to make Finite Element Analysis. With questionaire, all customer requirement and needs will be identified to facilitate the manufacture of the device.Additive manufacturing is one of technology that used in all manufacturing process. It is easy for engineers to produce a good prototype as well as to reduce the lead time of a product.

1.3 Problem statment

Currently, most of the supporting device for hand or wrist fracture made from cast or splint. According to Bernett (2007) patient usually need to wear cast or splint for a number of week. To reduce pain in hand and wrist, usually it used cast or splint as one of the healing device. Material for cast are plaster of paris or fiber class. When using a casts, it is too big because it used with two layers of stiff bandages. The inside layer, which rests against the skin, is made by soft cotton. The outer layer is hard to protect a broken bone from moving to

reduce injuries. Figure 1.3 shown layer of cast and it's usually made from one of two materials such as :

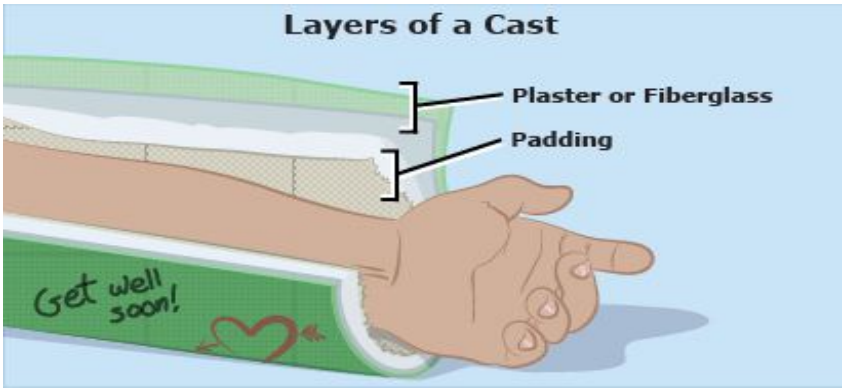

Figure 1.3: Layer of cast

(Source :< http://kidshealth.org/teen/safety/first_aid/casts.html> 29/09/13)

Plaster of Paris usually used for school art projects but in medical it used to heal properly when patient keep broken or injured bones from moving. A heavy white powder is mixed with water to form a thick paste that hardens quickly. Plaster casts are heavier than fiberglass casts and can start to dissolve if they get wet. It is difficult to patient to cure a plaster cast when take bath. If the plaster get wet, the surface of plaster cast will delicate. The picture below in Figure 1.4 shows an example of cast for hand broken using plaster of paris.

Figure 1.4: Example cast for broken hand using plastic of paris

(Source :< http://kidshealth.org/teen/safety/first_aid/casts.html> 29/09/13

Fiberglass is a type of moldable plastic available in many different colors. Fiberglass casts are lighter and cooler than plaster casts. The outer layer of a fiberglass cast is water resistant, but the inner layer is not, although it's possible to get a waterproof liner for a fiberglass cast. Fiber glass is ease to install and light however , it does not help when a patient have to take a bath.

There are a lot of device to support healing of fracture hand or wrist hand but it is not convince because they are not water proof and difficult to make a movement. when got fracture or injuries with hand or wrist, it not just hand or wrist because the soft tissue around it is often injured as well. When a cast or splint removed, hand or wrist need to get heal support for continues resting before tissue fully recover.