



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DESIGN, OPTIMIZATION AND FABRICATION OF A
3D PRINTING ORTHOPEDIC CALF CAST**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Automotive) with Honours.

By

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This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Automotive) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Percetakan betis ortopedik 3D adalah alat sokongan yang digunakan untuk mengawal dan membimbing sendi yang patah pada betis sehingga penyembuhan disahkan oleh doktor. Untuk reka bentuk yang sedia ada di Malaysia, plaster cast, ia akan menghasilkan banyak kelemahan kepada pesakit, seperti ketidakselesaan dan berat. Perkembangan teknologi terkini di dunia dalam industri ini berharap dapat menghasilkan produk yang ringan dan mesra pengguna. Satu projek telah dijalankan untuk menyediakan reka bentuk dan pembangunan kepada alat sokongan itu. Perisian Bantuan Berbantuan Komputer (CAD) dan perisian Analisis Unsur Hingga (FEA) digunakan untuk merekabentuk dan mengoptimumkan produk, tanpa memberi kesan keupayaannya untuk menahan berat badan pesakit. Dengan menggunakan beban berat yang berlainan, ia akan dianalisis untuk mendapatkan reka bentuk terbaik. Sistem T-Scan LV, mesin pengimbasan yang telah digunakan untuk proses imbasan. Kemudian, proses percetakan digunakan sistem sintering laser Farsoon SS 402P. Serbuk-serbuk Nylon FS3200PA dipilih untuk bahan acuan, kerana sifat antioksidannya umumnya baik, dan tiada kesan kesihatan yang buruk. Melalui pengoptimuman dan analisis, tiga model ringan terbukti sebagai model yang selamat digunakan. Tetapi, hanya satu model dengan faktor keselamatan 2.33 dan ketebalan 2mm akan dipilih untuk dicetak kerana ia mampu menampung berat tertinggi pesakit, 981N semasa cuba mencapai berat yang dikehendaki.

ABSTRACT

The 3D printing orthopedic calf cast was a support tool used to control and guide the fractured joint in calf until healing is confirmed by the doctor. Current design in Malaysia, plaster cast, it came up with many disadvantages to patient, like discomfort and heavy. This current technological world development in industries looking forward to come up with lightweight and user-friendly products. A project was carried out to provide the design and development of the support tool. Computer Aided Design (CAD) software and Finite Element Analysis (FEA) computer software were used to design and to optimize the product, without effect its possibility to withstand certain patient mass. By using different applied masses/loads, it will be analysed to find the best shape design. T-Scan LV system, the scanning machine that had been used for scanning process. Then, the printing process was used the Farsoon SS 402P laser sintering system. FS3200PA Nylon powder was chosen for the material of cast, as it is generally good antioxidative properties, and there are no known adverse health effects. Through optimization and analysis, three light models are proven to be a safe-to-use model. However, only one model with safety factor of 2.33 and thickness of 2mm is chosen for printing as it can withstand the highest patient weight of 981N while trying to achieve the desired mass.

DEDICATION

This dedication firstly to Allah S.W.T for giving strength and good health to perform this duty to complete this project. Great appreciation to my beloved and respectful parents, Tumijan bin Abu Bakar and Anita bte Mohd. Sa'ahat. Thank you for always give me support and motivation and I hope that this achievement will fulfil their dreams. Also dedicated appreciation to my siblings and my fiancée for giving me support and best dedicated appreciation to my supervisor for always guide and advise me.

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LIST OF SYMBOLS

m	-	meter
N	-	Newton
kg	-	kilogram
Pa	-	Pascal

LIST OF ABBREVIATIONS

3D	3Dimensional
SLS	Selective Laser Sintering
FEA	Finite Element Analysis
DSE	Digitive Shape Editor
QSR	Quick Surface Regeneration
GSD	Generative Shape Design
AM	Additive Manufacturing
RE	Reverse Engineering
FE	Finite Element

CHAPTER 1

INTRODUCTION

1.1 Background

In this chapter, an overview of design, optimization and fabrication of a 3D printing Orthopedic calf cast will be elaborated. The main idea, problem statement, objective and scope of this project will also be introduced.

1.2 Project Overview

The purpose 3D Orthopedic calf cast is a support used to control and guide the fractured joint in calf until healing is confirmed by the doctor. This Orthopedic calf cast is a 3D printed and ready to fit. One side is open for easier to wear the cast and once fitted, it closed with durable fastener.

A 3D Printing Orthopedic calf cast comes from using the latest in advanced manufacturing technologies, CATIA and Altair Inspire software. This cast is produced using lightweight FS3200PA Nylon powder material utilizing an Additive Technology called Selective Laser Sintering (SLS).

The 3D scanning and 3D printing is used widely in a variety of fields such as engineering, medicine, biology and other fields. This cast is produced using FS3200PA Nylon powder material utilizing an Additive Technology called Selective Laser Sintering (SLS). The 3D Scanning and 3D Printing is utilized broadly in a variety of fields, for example, engineering, medicine, science and different fields. In medicinal and science experts utilized 3D Scanning and Printing to make dental embeds, a human skull and models of organs.

1.3 Problem Statement

Most of hospitals in Malaysia are still using traditional method for custom made the cast which using material plaster of Paris and mold. This plaster and mold are cannot recycle. It should regularly be broken up, for swelling or off-swelling of the crack joint part may require a cast. An X-ray control also requires breaking up, as it is not want to expose the patient to the strong X-ray doses needed to penetrate the cast until healing is confirmed by the doctor (Evans,T.C., Gavrilovich, E., Mihai, R.C. and Isbasescu, I., E.L., Thelen, D., Martin, J. A., Allen, S. M., & SA, S., 2014).

The problem statement that will be mainly focused here are:

- a) What material that can help to produce lightweight Orthopedic cast for fractured joint in calf?
- b) How to design breathable and waterproof Orthopedic calf cast?
- c) Is this cast having a good strength of materials to withstand forces?

1.4 Project Objective

The objectives of this project are as follows:

- a) To design custom fit Orthopedic cast by using CATIA and Altair Inspire Software.
- b) To optimize the weight of cast that used material of FS3200PA Nylon powder.
- c) To fabricate the cast by using the 3D Printer machine, Farsoon SS 402P laser sintering system.

1.5 Project Scope

The project scope was shown below:

- a) The fractured joint in calf is choosing as the parameter for designing the cast.
- b) CATIA and Altair Inspire software very useful to design custom fit Orthopedic calf cast based on patient's measurement.
- c) Material of FS3200PA Nylon has good strength and lightweight for optimizing the weight of the cast compare to previous material, such as cement.
- d) 3D printing Orthopedic calf cast is fabricated and ready to fit.