UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FEASIBLE STUDY ON DENTAL RESTORATION USING TIME COMPRESSION TECHNOLOGIES

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

by

NURUL HATIQAH BINTI HARUN
B071110288
920201-06-5786

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I hereby, declared this report entitled “Feasible Study on Dental Restoration Using Time Compression Technologies” is the results of my own research except as cited in references.

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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's Degree in Manufacturing Engineering Technology (Product Design) (Hons.). The member of the supervisory is as follow:

……

(MR. HAMBALI BIN BOEJANG)

ABSTRAK

Teknologi pemampatan masa (TCT) adalah sebuah alat dan teknik kejuruteraan serentak dalam penghasilan produk moden dan proses pembangunan. TCT seperti kejuruteraan terbalik (RE) dan prototaip pantas (RP) telah berkembang secara meluas dalam bidang pergigian dan sektor perubatan. Penghasilan prototaip mekanikal yang pantas menjadikan ia tidak mustahil untuk menghasilkan komponen 3D kompleks cepat secara langsung dari reka bentuk berkomputer model. Proses pemulihan gigi di makmal pergigian mengambil masa yang lama. Oleh itu, projek ini cuba untuk memahami dan menentukan bagaimana pendekatan moden boleh digunakan dan menyumbang dalam proses konvensional. Objektif utama projek ini adalah untuk menghasilkan mahkota gigi dengan menggunakan teknologi pemampatan masa dan membandingkan proses konvensional terhadap pendekatan moden. Melalui eksperimen ia mendapati bahawa mahkota gigi tidak dapat dihasilkan disebabkan oleh beberapa faktor. Walau bagaimanapun, masa yang diambil untuk menghasilkan mahkota gigi dengan menggunakan pendekatan moden adalah lebih cepat, lebih pendek dan lebih mudah daripada proses konvensional. Akhir sekali, proses analisis akan dilakukan untuk menentukan bagaimana pendekatan moden boleh digunakan dan menyumbang kepada proses konvensional.

ABSTRACT

Time compression technologies (TCT) is a tools and technique for concurrent engineering within modern product and process development. TCT such as reverse engineering (RE) and rapid prototyping (RP) have been widespread in dentistry and medical sector. Rapid mechanical prototyping make it possible to quickly fabricate complex-shaped 3D parts directly from computer aided design model. The current dental restoration process in dental laboratory is time consuming. Therefore, this project wants to try to understand and determine how modern approach can be applied and contribute to the conventional process. The main objectives of the project are to produce dental crown by using time compression technologies and compare the conventional process against modern approach. Through the experiment it is finding that the crown is unable to be fabricated due to several factors. However, the time taken requires to produce the crown by using modern approach are faster, shorter and simpler than conventional process. Lastly, process analysis will be done to determine how modern approach can be applied and contribute to the conventional process.

DEDICATION

To my beloved parents,
Harun Bin Razali and Jamaliah Binti Unok.

Beloved siblings and friends.

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All praise to Allah the Almighty because of His Mercy and Blessing, I finally accomplished my final year project. I would like to express my deepest gratitude and appreciation to my supervisor Mr. Hambali Bin Boejang from Faculty of Engineering Technology, University Technical Malaysia Melaka (UTeM) for his tremendous help, advice, and unending guidance until I finally completed this project.

I would also like to thanks to all peoples that were involved in my project especially my lectures, assistant engineers, family and friends. Without their help, my project cannot be as successfully as today. Finally, I hope my thesis will be a good reference to other students that seek knowledge and information on feasible study on dental restoration using time compression technologies.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

CE	-	Concurrent Engineering
CAD	-	Computer Aided Design
CAM	-	Computer Aided Manufacturing
CMM	-	Coordinate Measuring Machine
CT	-	Computer Axial Tomography
MRI	-	Magnetic Resonance Scanning
RP	-	Rapid Prototyping
RE	-	Reverse Engineering
SLA	-	Strereolithography
SLS	-	Selective Laser Sintering
STL	-	Standard Triangulation Language
TCT	-	Time Compression Technology
UV	-	Ultraviolet
3D	-	Three Dimensional

REFERENCES

[1] Bradley c. (1998). The Application of Reverse Engineering in Rapid Product Development. Sensor Review. Vol. 18, No. 2, pp. 115-120.

[2] Sandu L., Topala F., Bortun C., Porojan S., (2007). Laser Scanning Applications for Three- Dimensional Teeth Model Reconstructions. Proceedings of The 2nd International Conference on Lasers in Medicine, Timisoara, July 5-7, 2007. Part 2.

[3] Boejang H., Basar M. F., Yahya M.S., (2013*). Time Compression Technologies For Engineering Technology*. 1st edition. Universiti Teknikal Malaysia Melaka: Penerbit Universiti Teknikal Malaysia Melaka

[4] Chang, C.C., Lee, M.Y. and Wang, S.H. (2006), "Digital Denture Manufacturing – an integrated technologies of abrasive computer tomography, CNC machining and rapid prototyping; Int. J. Adv. Manuf. Techno., Vol. 31, pp. 41-49

[5] Liu, Q., Leu, M. C. And Schmitt, S.M. (2006), "Rapid Prototyping in Dentsistry: Technology and Application", Int. J. Adv. Manuf. Techno., Vol. 29, pp. 317-35

[6] Azari A., Nikzad S. (2009). The Evolution of Rapid Prototyping in Dentistry: A Review. Rapid Prototyping Journal. Vol. 15/3, pp 216-225.

[7] Longwood Dental Group – Dental Crowns [online]. Available at: http://www.longwood-dental.com/dental-crowns/ [Accessed on 10/5/2014].

[8] How Product are Made - Dental Crown [online]. Available at: http://www.madehow.com/Volume-4/Dental-Crown.html#ixzz312Awycig. [Accessed on 7/5/2014].

[9] Dental Crown In Navan [Online]. Available at: http://boynedental.ie/smile-makeover/crowns/. [Accessed on 10/5/2014]

[10] Interview with Dr Muhammad Bin Jaya, Poliklinik Ayer Keroh, Melaka, 2014

[11] Impressions for Braces [Online]. Available at: http://stouffvillebraces.blogspot.com/2013/06/impressions-for-my-stouffville-braces.html. [Accessed on 10/5/2014]

[12] Interview with Puan Khadijah Binti Osman, Dental Technician, Klinik Pergigian Melaka Tengah, Melaka, 2014.

[13] How Dental PFM Crowns are Made [online]. Available at: http://studentz.squidoo.com/how-are-dental-pfm-crowns-made. [Accessed on 10/5/2014].

[14] Boejang H., Bakar A. N. S, Alkahari M. R., (2010). Analysis on Fused Deposition Modelling Performance.

[15] Stereolithography Frequently Asked Questions [Online]. Available at: http://sciproto.com/Home/Stereolithography+(SLA)/Stereolithography+FAQ/default.aspx. [Accessed on 7/12/2014]

[16] All Ceramic Crown "Tooth Preparation" – For Dental Student [Online]. Available at: https://www.youtube.com/watch?v=D1JGRwqLpao. [Accessed on 16/12/2014]

CHAPTER 1
INTRODUCTION

1.1 Background

Times Compression Technologies (TCT) is a tools and technique for concurrent engineering (CE) within modern approach and process development. Several selected CE tools and techniques of TCT are computer aided design (CAD), rapid prototyping (RP), rapid tooling (RT) and reverse engineering (RE).

The impacts of TCT on product design and development process are obvious. The tools have successfully facilitated manufacturers to cut short the product development process without degrading the product quality. Therefore, the product can be reached to the customers earlier than their competitor, and finally give profit to the manufacturer and their vendors.

Many TCT tools have been used by manufacturers to accelerate and optimize the manufacturing and development process. Automotive industry is one of the industries that implemented TCT in their development process. Many leading vehicle manufacturers have gained remarkable benefits from integrating virtual prototyping and virtual reality installed in their global engineering infrastructures.

TCT in medical and biomedical sector is also greatly expanding. Although the use of RP technology has been slow arriving in the medical arena, the potential of the technique is seen to be widespread. Various uses of the TCT within surgical

planning, prosthesis development and bioengineering have been used in medical and biomedical sector [1].

Besides, TCT also have been used in dentistry. Rapid mechanical prototyping is able to quickly fabricate complex-shaped 3D parts directly from computer aided design model. Therefore, this new method of modeling has raised many attentions in dentistry especially in the field of surgery and implantology [2].

1.2 Problem Statement

The current dental restoration process in dental laboratory is time consuming. One complete dental restoration might take several weeks before the patient can have it. Therefore, this project wants to try to understand and determine how modern approach can be applied and contribute to the conventional process [2].

1.3 Objectives of the Project

The main objectives of this project are:

(i) To produce dental crown by using Projet 3500HD an additive manufacturing machine.

(ii) To compare the conventional dental crown fabrication process against modern approach.

1.4 Scope of the Study

This research project will focuses on method of making dental crowns by using time compression technologies including reverse engineering (RE) and rapid prototyping (RP). Then, process analysis will be done to determine how modern approach can be applied and contribute to the conventional process.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Time compression technologies (TCT) is a tools and technique for concurrent engineering (CE) within modern product and process development. Some of the several selected CE tools and techniques of TCT are reverse engineering (RE), and rapid prototyping (RP). This new method of modeling has raised many attentions in dentistry especially in the field of surgery and implantology. With this technology dentist is able to quickly fabricate complex parts directly from CAD model. Besides, it is also able to save dentist chair time and remove one link between the patient-dentist operational field and dental laboratory technicians. In this project, TCT will be used to produce dental crowns by using RE and RP systems.

2.2 Reverse Engineering (RE)

Before the automation era, most products were developed initially through human skill and were entirely handmade. The process of copying an object was done through measurement and observation. During 1960's automation made RE through copying process even a lot faster and broader in its application. Reverse engineering refers to a technology used to capture data or information of physical object through a process known as digitizing or scanning [3]. Today, there are so many RE

technologies available commercially with different specifications and ranges. There are categorized into contact or non-contact method.

RE is a one of the most recent technological developments that has a significant impact on product development cycle, and enables manufacturers to overcome problematic free form product geometry. Generally, a clay model or sculptured wooden mock-up of a product will be digitized or scanned to obtain its graphical representation at design stage before being manipulated for downstream operational applications.

2.2.1 Reason for RE Implementation

The main reason for manufacturer to implement RE in its product development process is to remain competitive in the market. However, there are some other reasons for the end users to choose RE, as the solution to their design problems, which may be classified into one of the following circumstances [3]:

- No CAD data of an old product.
- Artefact or hand crafted product.
- Any modification made on site or in production line without record.
- Copy or duplicate existing product (may be illegal).
- Natural product (i.e human body, teeth).
- Inspection

2.2.2 RE Process Chain

The RE process starts with digitizing or scanning of the physical object for the generation of digital representation of the object. This representation is known as point cloud. Figure 2.1 shows the example of point cloud view from the teeth surface.

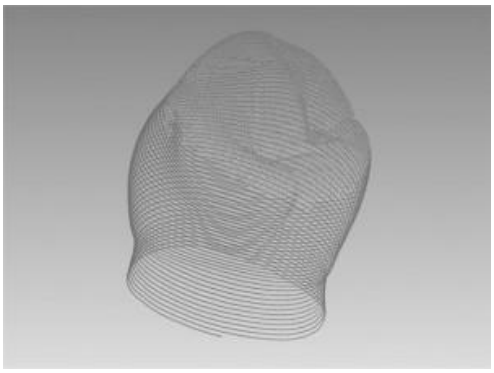

Figure 2.1: Point Cloud from the Teeth Surface [2].

Once the physical object is scanned, the point cloud data would be manipulated by using RE software such as Geomagic™ according to a particular application. The manipulation of point cloud is carried out in order to produce polygonal mesh or model before being transformed into CAM or a STL file format for prototype making and tooling [1]. Figure 2.2 shows a generic workflow of RE within rapid product development process.

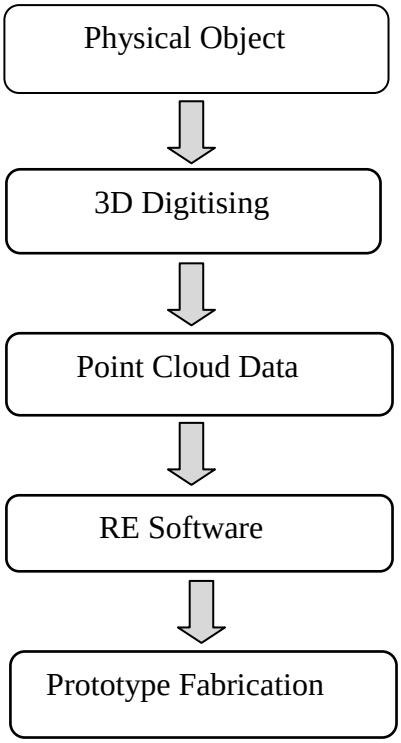

Figure 2.2: A Schematic Diagram of Integrated RE Within Rapid Product Development Process

2.2.3 RE in Dentistry

The first attempts for computer-assisted production of dental restoration were in 1971. The development in the area of computer-aided design/computer aided manufacturing (CAD/CAM) systems was then accelerated by commercialization of portable computers. This technology has grown in dentistry in the late 1980s and the introduction of first commercial product by incorporating the engineering principles has stimulated further interest. Soon after, it was feasible to produce crowns with CAD/CAM technology to fit as well as the produced with conventional casting conditions.

The main benefit of this type of machining system was that impressions are not needed anymore. For a long time, impression was taught in dentistry as a cheap and easy to use technique however requires skilful human effort. By using this technology, it is believe to save the dentist chair time and remove one link between the patient-dentist operational field and the laboratory technician [4].

In the modern approach, CAD technology uses data acquisition namely digitizing in contrast of conventional impression technique. It showed that two different forms of digital data capturing system are used in dental CAD technology; contact and non-contact digitizing methods [5].

Gathering information from internal structures requires different steps for data capturing which is not possible with merely optical or touch probe surface capturing devices. This problem has resolved by an innovating technology of computer axial tomography scanning (CT) and magnetic resonance scanning (MRI) [6]. One of the most benefits of this scanning images is that they posses no magnification errors caused by geometric distortions. Where such errors are common caused by conventional dental radiographs.