"I/We admitted had read this report and from my/our view, this report is eligible in scope and quality for the purpose of fulfilling the requirement for the Bachelor of Mechanical Engineering (Design and Innovation)"

Signature :…………………………………………..
First supervisor :…………………………………………..
Date :…………………………………………..

Signature :…………………………………………..
Second supervisor :…………………………………………..
Date :…………………………………………..

"I hereby declared that this thesis titled
„The Design of a Pre-Assembly of Blood Collection Tube Mechanism" is the result of my own effort except as cited in references".

Signature : ……………………
Name of Author : ……………………
Date : ……………………

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In this semester where PSM subject had take place, I had gain a lot of valuable experience and knowledge that cannot be learnt inside a classroom only. Teamwork and endurance with an addition of creativity is a must in getting through the real life of an engineer and that is what I had learnt throughout all the completion of this PSM report and it will be forever be kept as a message deep in my heart and my mind.

ABSTRACT

The design of a pre-assembly of blood tube mechanism is a study done on a very simple thing that most of us take it for granted. It is a simple process which is to assemble three pieces of the blood collection tube mechanism which consists of the tube, top cap and the rubber valve. All these parts need to be positioned in such a position so that it could be assembled. The study starts with the studies of the concept needed to get the process done and for that, the vibratory bowl feeder system were chosen. Based from the existing design of the vibratory bowl feeder, the customized bowl feeder that could align the top cap was designed. The traps and all the logic involved to ensure that the device works were taken into consideration thus creating a system that were possibly fool-proof enough for the assembly process to take place. Extra systems were added into the existing vibratory bowl feeder system such as the camera, riser, alignment and the punching mechanism. All these system were combined under the logic to pre-assemble the blood collection tube mechanism before it goes into the vacuum chamber for vacuum process so that the blood collection tube is usable for blood collection process. The design were later discussed on the design specification and the reliability of the design and the future or the improvement that could be done if this project could be taken further by any inspired students for further studies.

ABSTRAK

Projek rekabentuk untuk pra-pemasangan tiub pengumpul darah adalah kajian tentang perkara yang ramai di antara kita yang tidak berapa ambil peduli. Ia adalah satu proses yang mudah dimana tiga bahagian tiub pengumpul darah yang terdiri daripada tiub, penutup atas dan injap getah dicantumkan untuk membentuk sebuah sistem untuk mengumpul sampel darah. Bahagian-bahagian tersebut perlu dicantumkan dengan orientasi yang tertentu supaya ianya dapat dicantumkan. Kajian tantang topik ini dimulakan dengan pencarian konsep yang paling sesuai untuk memenuhi kriteria yang telah ditetapkan dan sistem penyuap mangkuk bergetar telah dipilih .Perangkap dan sistem logik yang terlibat telah dikenalpasti dan ini telah menghasilkan sebual sistem yang hampir sempurna untuk proses pra-pemasangan tiub pengumpul darah boleh berlaku.sistem tambahan juga telah ditambah kepada sistem penyuap mangkuk bergetar seperti kamera, penaik dan sistem pemukul. Semua sistem ini telah dicantumkan di dalam sebuah sistem untuk membentuk sebuah logik yang mampu untuk menjalankan proses pemasangan tiub pengumpul darah sebelum tiubtersebut dimasukkan ke dalam ruang vakum untum di vakumkan supaya tiub tersebut dapat digunakan untuk proses pengambilan darah. Rekabentuk proses pra-pemasangan tersebut telah dibincangkan berkenaan tentang spesifikasi dan keboleh harapan rekabentuk sistem tersebut serta masa depan projek ini juga telah dibincangkan berkenaan sekiranya jika projek ini boleh dimajukan lagi oleh pelajar yang berminat pada semester yang akan datang.

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CHAPTER 1

INTRODUCTION

1.1 Project Background

„Projek Sarjana Muda" is a compulsory syllabus needed for each student of Universiti Teknikal Malaysia Melaka, (UTeM) to participate and contribute their knowledge in order for them to receive their bachelor"s degree in mechanical engineering. This goes for the PSM where students will be given a chance to prove themselves through series of theories, research, experiments, analysis, optimization and a whole lots more method known to the engineering world.

The project decided for my PSM is to design and possibly fabricate an assembly process of blood collection tube to be inserted into a vacuum chamber machine. The machine had been designed and fabricated within UTeM laboratory with collaboration from UPM.

Blood collection tube is a tube shape exactly like a test tube but with a color coded cap used to collect blood during blood sampling procedure or in medical term, *phlebotomy*. It is commonly vacuumed so the usage of syringes as in traditional method of phlebotomy is not needed.

By using a syringe, the patient"s skin need to be punctured and by pulling the lever on the syringe, the blood is collected and then the collected blood will be inserted into a test tube where it will be stored for testing. When using a vacutainer, the process is a bit different where the blood does need to be transferred into another vessel after being taken but it is taken directly into the test tube that will hold it for further testing.

1.2 Problem Statement

Currently the tubes were assembled by hand and it will be arranged into its holder manually. It is a right option considering only a few blood collection tubes will be processed in a single run. The problem lies when we had designed a holder mechanism that could contain 100 tubes at a time. The process need to be automated where all the manual process before need to be converted to mechanical machineries.

Our concern in this PSM is the process on how the tube will be assembled. The tube itself consists of three different parts: the tube itself, stopper and the color coded cap. A process flow is need to be constructed and what types of machineries or devices to handle the process flow need to be decided.

The stopper and cap does not need to be fitted tightly so that the vacuum process could be done on the tube. The problem is to know just how much pressure needs to be applied onto the stopper so that it will still leave a space or an airway for the vacuum process to be done.

Arrangements of the tubes into the holder also considered as a crucial part. 100 tubes need to be arranged into the holder into each of their slot provided without any manual process.

Sorting devices, positioning devices, mechanical insertion devices and a lot of sensors need to be considered in making this process cycle.

1.3 Objectives

To study and design a pre-assembly for blood collection tubes before the vacuum process takes place.

1.4 Scope

- Conduct literature study regarding the topic given.
- Design concepts that fulfill engineering design specification.
- Determination of standard parts.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Blood Collection Tube Assemblies

The usage of an assembly line to assemble blood collection tube is still being kept a secret and one could only guess how the process look like and for that reason, the studies on this topic is going to be more to an assumption and we will find the most logical and appropriate way to assemble the blood collection to prepare them to be vacuumed. Even though the sources may be scarce but the main idea could still be found which is;

We will study the basic concept of a blood collection tube and how it works along with the biological knowledge alongside the devices. The standards of blood collection tube, dimensions and constraints manufacturers need to follow when making a blood collection tube.

For this research, we will focus and study mainly about the prototype blood collection tube that been produced beforehand as our test subject. If the design for these particular types of blood collection tube works, it could be design to fit the specs of other blood collection tube as well and our future ambition is to produce a process that could be used universally on all types of blood collection tube.

2.2 Venipuncture

In medicine, venipuncture or venepuncture is a process of subtracting intravenous access for the purpose of intravenous therapy or obtaining a sample of venous blood. The procedure usually performed by medical practitioners, including paramedic staffs, nurses or doctors.

Blood is most commonly obtained from the median cubital vein, on the anterior forearm (the side within the fold of the elbow). This vein lies close to the surface of the skin, and there is not a large nerve supply.

Phlebotomy (incision into a vein) is also the treatment of certain diseases such as hemochromatosis and primary and secondary polycythemia.

Figure 2.1: Venipuncture procedure (source: Wikipedia.com)

2.3 Equipment Used

There are many ways in which blood can be drawn from a vein. The best method varies with the age of the patient, equipment available and tests required.

Most blood collection in the US and UK is done with an evacuated tube system, such as the BD Vacutainer system or similar blood collection equipment consisting of a plastic hub, a hypodermic needle, and a vacuum tube. Under certain circumstances, a syringe may be used, usually with a butterfly needle, which is a plastic catheter attached to a short needle. In the developing world, where medical supply is crucial, a needle and syringe are still the most common method of drawing blood.

Figure 2.2: Blood collection kit (source: salvin.com)

2.4 Vacutainer

Vacutainer is a registered brand of test tube specifically designed for venipuncture. It was developed in 1947 by Joseph Kleiner and is currently marketed by Becton, Dickinson and company. (*Source: howstuffworks.com*)

Figure 2.3: Vacutainers on a rack (source: Wikipedia.com)

2.4.1 Principles of Vacutainer

The vein is first punctured with the hypodermic needle which is carried in a translucent plastic holder. The needle is double ended, the second shorter needle being shrouded for safety by the holder. When a Vacutainer test tube is pushed down into the holder, its rubber cap is pierced by the second needle and the pressure difference between the blood volume and the vacuum in the tube forces blood through the needle and into the tube. The filled tube is then removed and another can be inserted and filled the same way. It is important to remove the tube before withdrawing the needle, as there may still be some suction left, causing pain upon withdrawal.

2.5 Blood Collection Tubes Studies

Chosen subject; UPM blood collection tube prototype

Parts involved in the blood collection tube;

Table 2.1: Parts of blood collection tube

Parts	**Description**
 Top cap	Material = plastic Dimensions ; Diameter = 16mm Length = 21.15mm Weight = 0.67g
 Rubber valve	Material = rubber Dimensions ; Diameter = 12mm Thickness = 10mm Weight = 1.13g
 Tube	Material = plastic Dimensions ; Diameter = 12mm Length = 74.2mm Weight = 1.59g