

DESIGN OF LAB – SCALE PRE-PREGGER MACHINE  
FOR IN HOUSE PRODUCTION OF PRE-PREG  
MATERIAL

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2014



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**  
**(UTeM)**

**DESIGN OF LAB - SCALE PRE-PREGGER MACHINE FOR IN  
HOUSE PRODUCTION OF PRE-PREG MATERIAL**

This report is submitted with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Robotics and Automations) (Hons.)

by

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## DECLARATION

I hereby, declared this report entitled ‘Design of Lab – Scale Pre-Pregger Machine For In House Production of Pre-Preg Material’ is the results of my own research except as cited in references.

Signature : .....

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Date : 23<sup>th</sup> June 2014

## **APPROVAL**

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

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## ABSTRAK

Bahan *pre-preg* digunakan secara meluas untuk menghasilkan bahan komposit dalam industri komposit. Tujuan projek ini adalah untuk mereka bentuk mesin *pre-pregger* berkonsep skala makmal dalam pengeluaran rumah bagi bahan *pre-preg*. Idea utama adalah untuk mengurangkan saiz mesin yang sedia ada dan mengurangkan kos untuk membina mesin tersebut. Konsep reka bentuk yang dicadangkan mesin adalah terhad kepada proses *pre-pregging* untuk pita *pre-preg* yang mempunyai satu arah. Projek ini dibahagikan kepada dua bahagian: reka bentuk dan konsep kawalan strategi. Konsep reka bentuk mesin *pre-pregger* dilukis menggunakan perisian AutoCAD dan SolidWork 2014 untuk digunakan bagi tujuan simulasi. Pada peringkat ini, reka bentuk memberi tumpuan kepada empat komponen utama: Gendang, *resin bath*, *guider* dan serat gelendong. Mesin *pre-pregger* direka dengan gendang fleksibel yang boleh dipasang dan dikeluarkan dengan mudah dari pemegang gendang. Gendang direka dengan dua saiz: 300 mm dan 600 mm diameter. Saiz yang berbeza dalam garis pusat akan membuat mesin menjadi lebih fleksibel. Dalam ketika yang lain, *Programmable Logic Controller* (PLC) telah dipilih untuk mengawal mesin *pre-pregger*. CX-ONE OMRON PLC digunakan untuk rekabentuk rajah tangga pengawal. Dalam usaha untuk merangsang dan menguji kebenaran pengawal, persediaan tenaga elektrik yang ringkas telah dibuat. Persediaan terdiri daripada tiga motor, sensor dan butang tekan. Persediaan simulasi membuktikan bahawa reka bentuk konsep cadangan mesin *pre-pregger* adalah boleh dilaksanakan. Secara ringkasnya, tujuan projek itu telah berjaya dicapai. Adalah diharapkan bahawa pembinaan mesin *pre-pregger* berskala makmal boleh dibuat dalam masa terdekat

## **ABSTRACT**

Pre-preg material is widely used to produce a composite material in the composite industry. The aim of this project is to conceptually design a lab-scale pre-pregger machine for in house production of pre-preg material. The main idea is to decrease the size of the existing machine and reduce the cost to fabricate it. The proposed conceptual design of the machine is limited to a pre-pregging process for a unidirectional pre-preg tape. This project is divided into two junctures: conceptual design and control strategies. The conceptual design of the pre-pregger machine is drawn using AutoCAD software and SolidWork 2014 is used for simulation purpose. At this stage, the design focuses on four major components: drum, resin bath, guider and fiber spindle. The pre-pregger machine is designed with a flexible drum which can be installed and removed easily from the drum holder. The drum is designed with two sizes :300 mm and 600 mm in diameter. The different size in diameter will make the machine become more flexible. In another juncture, Programmable Logic Controller (PLC) was chosen to control the pre-pregger machine. The CX-ONE OMRON PLC was used to design the ladder diagram of the controller. In order to simulate and test the correctness of the controller, a simple electrical setup has been made. The setup consists of three motors, sensors and push button. The simulated setup proved that the proposed conceptual design of the pre-pregger machine is workable. In a nutshell, the aim of the project has been successfully achieved. It is hoped that the development of the lab-scale pre-pregger machine can be made in the near future.



## DEDICATION

*This report is dedicated especially to my beloved family, my parents*

*(En Mohamad bin Yacceb and Puan Lijah binti Mohd)*

*My sisters and my brothers*

*And lastly to all my friends that give me a support while doing this project*

*Thanks you very much*

## ACKNOWLEDGEMENT

I would like to gratitude to Allah S.W.T for His generous blessing and undying strength bestowed upon me during the course of this research.

First of all, I am highly grateful to my university, Universiti Teknikal Malaysia Melaka (UTeM) for allowing me to do my PSM project.

Secondly, I would like to my PSM supervisor, Mr. Muhamad Arfauz bin A. Rahman for convincing me the fact “whatever a man can imagine, that can be achieved”, treating me as a daughter of his own and guiding me to conduct this project. Without helping from him, I surely I have a problem in completing the PSM writing report.

At the same time, I would like to deeply thank to Dr Zaleha bt. Mustafa as my co-supervisor that give me a lot of information about the project. Besides that, her cooperation indeed makes my work become easier and faster.

Last but not least, I would like to express my heartfelt gratitude to my parents, the persons whose are always be the backbone to me. Lastly, to all my friends, thanks a lot in giving me strength, constructive suggestion, idea and also criticism. Thank you.

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# **LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURES**

PLC – Programmable Logic Controller

PIC – Programmable Integrated Circuit

NO – Normally Open

NC – Normally Close

LS – Limit Switch

DC – Direct Current

AC – Active Current

CAD – Computer Aided Design

CW – Clockwise

CCW - Counterclockwise



# **CHAPTER 1**

## **INTRODUCTION**

### **1.1 Background**

The first pre-preg machine was developed in the late 1960s to support the production of carbon fiber tape for the manufacture of composite structures on a U.S. National Aeronautics and Space Admin. (NASA) lunar lander (Jeff Sloan, 2013). At that time, resin systems were, for the most part, difficult to mix, catalyze, process consistently and manage during production. Because of this, most pre-preg manufacturing fell to large chemical companies and resin producers (Jeff Sloan, 2013).

The use of lab-scale pre-pregger machine for in house production of pre-preg material is well-known in composite manufacturing plant due the pre-pregger machine can be used to align fiber that being impregnated with the resin out drum to produce unidirectional pre-preg material. Besides that, the machines use a controller to control the movement of the machine. The drum is rolled continuously while the roller of the pre-preg material will be moved upward and backward. This is because to avoid the pre-preg material does not roll at the same place.

In addition, there is some problem that has been faced by the supplier to design and produce this pre-pregger machine. The problem is the size of the pre-pregger machine and the cost investment to produce the machine. The largest size of the machine, the highest the cost that is needed to produce the machine. For example, a pre-preg carbon fiber in the U.S. for its parent company, Tokyo, Japan-based Toray Industries said that the size of the pre-preg machine makes it possible for them to take advantage of economies of scale as they produce off-the-shelf material designed to meet a particular specification (Jeff Sloan, 2013).

Last but not least, the pre-pregger machine used a controller to control the movement of the machine. The controller that is commonly used to control the machine is Programming Logic Controller (PLC). PLC is used as computer industry in electromechanical automatic process. Besides that, PLC is a special program that is designed for the purpose of controlling a wide variety of manufacturing machines and systems in the plant. The programming that is used by this software can make it simple and easy to use. Moreover, most of the manufacturing factory is now extensively use of machine controlled by PLC. There are a lot of the benefits of the PLC including flexibility, error correction, visual observation and cost saving.

Lastly, this project is about to design a lab-scale pre-pregger machine for in house production of prepreg material. The design is based on two categories which are conceptual design and control strategies of the pre-pregger machine.

## **1.2 Problem Statement**

Commonly, the existing pre-pregger machine has a large size and heavy to carry. The drum has a size between 1000 mm until 2000 mm. the width has a diameter between 300 mm until 1100 mm. Since the size is big, the pre-pregger machine has a higher cost to produce. This cost is based on the material that is used and the design of the machine. Therefore, this project is to design a machine that has a lab scale size and can reduce the cost to manufacture it.

### **1.3 Objective**

The objectives of this project are:

- a) To develop a conceptual design of the lab-scale pre-pregger machine for in house production of pre-preg material.
- b) To design a control strategies for the controller in lab scale pre-pregger machine.

### **1.4 Scope**

The scope of this project is to design a conceptual and control strategy of the lab-scale pre-pregger machine in house production of pre-preg material. The design process is by combination between two CAD software which are AutoCAD 2013 software for drawing and SolidWork 2014 software for the simulation testing. This is because of the limitation skill in both of the software. The control process is programmed in CX-ONE OMRON PLC software to design the control strategies of the lab-scale machine. After that, the limitation for this project is by developing a simulation about the movement of the drum that utilize in unidirectional movement which are clockwise and counterclockwise rotations.