



Faculty of Engineering

**DESIGN OF CONTROL SYSTEM FOR THE
POKA YOKE WAGON DOLLY**

Syamsul Akmal Bin Ahmad Kamil Saraidin

Bachelor of Engineering with Honours
(Mechanical Engineering and Manufacturing Systems)
2004

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Universiti Malaysia Sarawak

BORANG PENYERAHAN TESIS

Judul: Design of Control System for the Poka Yoke Wagon Dolly

SESI PENGAJIAN: 2003/2004

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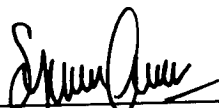
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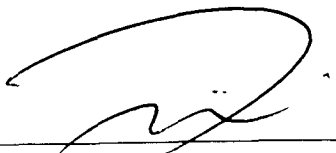
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APPROVAL SHEET

This project attached hereto, entitled "Design of Control System for the Poka Yoke Wagon Dolly" is prepared and submitted by Syamsul Akmal Bin Ahmad Kamil Saraidin in partial fulfillment of the requirements of Bachelor's Degree with Honours in Mechanical Engineering and Manufacturing Systems is hereby accepted.



(Mr. Syed Tarmizi Syed Shazali)

15-04-2004

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**DESIGN OF CONTROL SYSTEM FOR THE POKA YOKE WAGON
DOLLY**

P.KHIDMAT MAKLUMAT AKADEMIK
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This project is submitted in partial fulfillment of
the requirements for the degree of Bachelor of Engineering with Honours
(Mechanical Engineering and Manufacturing Systems)

Faculty of Engineering
UNIVERSITI MALAYSIA SARAWAK
2004

Dedicated To My Beloved Family

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ABSTRACT

A programmable logic control system is an essentially device to control machinery and equipment without complexity of the wiring, relays and timers that would normally be required. The programmable logic control system used a programmable memory for the internal storage of instructions for implementing specific functions such as logic, sequencing, timing and arithmetic to control through analog or digital input or output modules, various types of devices and process. The Poka Yoke Wagon Dolly project was developed which included the processes such as manufacturing, designing, analysis, PLC software control, wiring design and electrical selection. The control system for the wagon dolly is designed with the concepts of poka yoke (mistake-proving) system. The project report presents the documentation of developing the control system that operates the Poka Yoke Wagon Dolly. Techniques of writing the ladder diagram which drawn using GPPW software to operate the machine prototype using Mitsubishi PLC control system has been developed. A flow chart of the process operation was drawn to implement the ladder diagram. The wiring diagrams for all electrical and electronic components also included. The method for troubleshooting, commissioning and debugging process of PLC and electrical components were done to ensure the safety and efficiency of the system.

ABSTRAK

Sistem kawalan pemrograman logik adalah merupakan satu alat untuk mengawal mesin dan peralatan mesin dengan tanpa menggunakan pendawaian rumit yang sepertimana diperlukan untuk pendawaian peralatan yang biasa. Sistem ini memerlukan set aturcara spesifik sebagai program memori untuk melaksanakan fungsi-fungsi seperti logic, masa, penyusunan, arimetik dalam mengawal input dan output daripada peralatan-peralatan mesin. Projek Poka Yoke Wagon Dolly dibina merangkumi proses-proses seperti pembuatan, fabrikasi, mereka bentuk, menganalisis, aturcara pengawalan PLC (Programmable Logic Controller), pendawaian, pemasangan dan pemilihan komponen elektrik. Sistem kawalan yang direka kepada wagon dolly menerapkan aplikasi konsep sistem 'poka yoke' (pembetulan kesilapan). Laporan projek ini memperihalkan dokumentasi dalam pembinaan sistem kawalan yang mengoperasikan Poka Yoke Wagon Dolly. Satu aturcara tangga (ladder diagram) yang dilukis dengan menggunakan perisian GPPW yang berfungsi untuk mengoperasikan prototaip mesin yang menggunakan sistem kawalan PLC jenis Mitsubishi. Satu carta aliran dalam proses operasi dibuat untuk menjalankan aturcara tangga tersebut. Pendawaian untuk semua komponen elektrik dan elektronik juga disertakan. Proses *troubleshooting*, *commissioning* dan *debugging* untuk PLC dan komponen-komponen elektrik telah dijalankan untuk memastikan keselamatan dan kecekapan dalam sistem.

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CHAPTER 1

INTRODUCTION

CHAPTER 1

INTRODUCTION

1.0 Overview of the Poka Yoke

The concept of Poka Yoke has existed for a long time in various forms; it was Japanese manufacturing engineer Shigeo Shingo who developed the idea into a formidable tool for achieving zero defects and eventually eliminating quality control inspections. The term Poka Yoke, generally translated as mistake-proofing or fail-safe. The idea behind Poka Yoke is to respect the intelligence of workers. *By taking over repetitive tasks or actions that depend on vigilance or memory, Poka Yoke can free a worker's time and mind to pursue more creative and value-adding activities* [Shigeo Shino, 1986].

Many things can go wrong in the complex environment of the workplace; everyday there are opportunities to make mistakes that will result in defective products. Defects are wasteful, and if they are not discovered, they disappoint the customer's expectations of quality. Behind Poka Yoke is the conviction that it is not acceptable to produce even a small number of defective goods. *To become a world-class competitor, a company must adopt not only a philosophy but a practice of producing zero defects. Poka Yoke methods are simple concepts for achieving this goal* [Shigeo Shino, 1986].

1.1 Overview of the Wagon Dolly

Wagon Dolly can be defines as small racking machine or racking table car that used to connect the human operator with racking part system and the process assembly at the production lines. Wagon Dolly is used as the temporary place for the certain amount of parts and tools (referred to the small components) before they were installed to the car or before the operators put them into the processes (assembly works). By using it, the operators can save their steps a lot during working compared if their using the usual parts rack system at line sides for done the same jobs.

The concept of the Wagon Dolly was originated by Mitsubishi Motor Corp. in order to reduce the setup time in production area. Nowadays, the idea of Wagon Dolly was widely used in the automotive manufacturing sector included Perusahaan Otomobil Nasional Berhad (PROTON) as the Malaysian Car Manufacturer. Most of the station at the production lines in the PROTON factories are using it because of their benefit to reduce the setup time and increased the ratio of machinery utilization to its full capacity.

1.2 Overview of the Poka Yoke Wagon Dolly

Poka Yoke Wagon Dolly is a new student final year project that developed in UNIMAS by two undergraduate's student of Mechanical Engineering and Manufacturing System Program, Mr. Syamsul Akmal Bin Ahmad Kamil Saraidin, the author and Mr. Wan Sharuzi Wan Harun. Basically this project is divided into 2 parts:

- a) Mechanical design, analysis, fabrication and installation: handled by Wan Sharuzi Wan Harun.
- b) Electrical wiring, circuit diagram and control system. Included the PLC programming, electrical circuit wiring, electrical parts and component installation, circuit design, control system design, troubleshooting, test run, control panel box and installation: handled by Syamsul Akmal Bin Ahmad Kamil Saraidin.

This project is mainly inspired by the potential of automation applications in the elimination of the wasteful activities at the workstation. The control system for the Wagon Dolly will be design with the concepts of Poka Yoke system. This equipment will be used in the case that critical and important area where mistake (defect) always happen. The system will guide the operator based on Standard Operation Procedure (SOP) to complete the work process at that area. The system also will detect the sequence error or any wrong specifications installation.

1.3 Objective of the Poka Yoke Wagon Dolly

Poka Yoke Wagon Dolly project is to be complete in one year time. The objectives of the project are listed as below:

- (a) To apply the following techniques into practice and application.
 - Mechanical design and fabrication.
 - Electrical wiring.
 - Electrical control system and process sensing..
 - Industrial process controller, the Programmable Logic Controller.

- (b) To have a basic understanding of the technology aspects, and some basic theory of practical control systems.
- (c) Implement the Poka Yoke system ideas and methods in product design and process design which eliminate both human and mechanical errors.
- (e) To improve problem solving skills by thinking analytically and practically.
- (f) To understand the control of machines and processes widely used in manufacturing.
- (g) Simulation industrial practice on a realistic industrial system model.
- (h) To develop a prototype based on the proposed design.

1.4 Rational of the project

Poka Yoke Wagon Dolly is similar in operation to the mechanical checks and is widely used in both machine and manual operations. Unlike the mechanical checks, however, the Wagon Dolly system is used to eliminate defects that may occur due to an oversight on the worker's part.

The system consists of a detecting instrument, a restricting tool, and signaling device. The detecting instrument will sense the abnormalities or deviations in the process, where the scope of study for this project will be focus in term of the processes sequences error and miss processes that happen in the work area. The restricting tool will function as the emergency button to stops the process immediately. The signaling device sounds a buzzer or lights a lamp to attract the worker's attention.

The Implementation of the Poka Yoke Wagon Dolly at the working area will guide the operators to do the jobs correctly without any errors as followed the Standard Operation Procedure (SOP) provided at the work places.

It is the basic principle of *do not let defects pass*. It is can be done through early stage of prevention. As all known, that as a human being, we are always going to make a mistake no matter how simple the things are. In the implementation of this project, the author can foresee the challenges waiting to get fully expose to real practice of the control system instead of gaining the knowledge from books and lecture hall.

As a result it is important to learn the control system and apply it practically due to industrial process control systems, which are getting very important on par with computer and electronic technology.

CHAPTER 2

LITERATURE REVIEW

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

In the scientific research it is always important to study the work of others in the related field to understand the method employed. So that, a better overall approach towards the implementation of the research plan can be done.

This chapter will review various work done previously and also currently by others in control system and manufacturing field. The literature review will focus on characteristics and functions for those reviews:

1. Review on the type of the Control System.
2. Review of the Poka Yoke System.
3. Review of the Tightening Equipment Poka Yoke System by PROTON MVF T/F Shop Floor.
4. Review of the Fool-proof system at Toyota Production System.
5. Review on the Wagon Dolly system at PROTON.
6. Review of the Programmable Logic Control (PLC).

2.1 Review on the type of the Control System

Control system in general can be divided into two broad categories, open loop and closed loop. It will determine at fixed point of time, the system under