

TOTAL DESIGN OF A PORTABLE AUTOMATION TRAINING KIT

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“I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design and Innovation)”

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**This report is submitted in fulfillment of the requirements for the Bachelor of
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**Fakulty of Mechanical Engineering
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June 2013

STUDENT DECLARATION

“I hereby declare that the work in this report is my own except for summaries and quotations which have been acknowledged.”

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Dedicated to

My Beloved Parents

Relatives and Siblings

Classmates and Friends

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ABSTRACT

In the age of industrial automation the high demand of product are the prominent activities that can improve the productivity in manufacturing line. Thus to increase this productivity the basic knowledge about automation in industry should be presented clearly through the effective training tools. A total design of portable automation training kit is a device to help trainee to understand the particular operation system that has programmed into the modules which is connected with Programmable Logic Controller (PLC) integration. A portable automation of training kit would be provided to engineers, technicians, machinist and university or college students to indoctrinate the usage and application of automation technology which is to ease trainer to bring them at any places for their training purpose. During training course, student will be provided opportunity to look on the running process of automate machine through modules application and understand the relationship between PLC, motors and how they coordinated to each other. According to the design there would consider the usability, portability and also the feasibility factors on every components in training kit that would be used. The procedure to conduct this project has begun with an investigation on current problem design for new portable automation training kit in marketing. Then continue with design of portable automation training kit model, conceptual development model with six process including the brainstorming process, house of quality, conceptual design, morphological table, objective tree and lastly it comes to weighted objective method to generate the final design model. After that, there has undergoes with integration of prototype model, documentation session and finally improvement for design prototype which has been done after considered their problem which could arises.

ABSTRAK

Dalam menuju era kemajuan perindustrian automasi, permintaan yang tinggi terhadap produk menyebabkan peningkatan produktiviti yang pesat dalam industri pembuatan. Oleh itu, pengetahuan asas mengenai automasi dalam industri perlu diperluaskan melalui alat bantuan latihan yang berkesan. Satu reka bentuk alat latihan automasi mudah alih ialah alat untuk membantu pelatih dalam memahami aplikasi sistem yang telah diprogramkan ke dalam modul dimana ianya dipasang bersama dengan integrasi pengawal logik boleh atur. Alat bantuan ini disediakan kepada jurutera, juruteknik, juru mesin mahupun pelajar universiti atau kolej untuk mengindoktrinasi penggunaan dan aplikasi teknologi dalam automasi yang bertujuan untuk memudahkan jurulatih membawa alat tersebut ke mana-mana tempat untuk tujuan pembelajaran. Sepanjang latihan, pelajar akan didedahkan tentang bagaimana proses sesuatu aplikasi modul itu berfungsi melalui integrasi bersama mesin ringkas yang terlibat di dalam alat bantuan automasi mudah alih seperti pengawal logik boleh atur cara, motor dan bagaimana mereka diselaraskan antara satu sama lain. Alat bantuan automasi mudah alih ini akan mengetengahkan faktor kebolegunaan, fungsi mudah alih produk ini serta kesan kemungkinan yang akan berlaku terhadap reka bentuk pada setiap bahagian alat bantuan. Prosedur untuk menjalankan projek ini telah bermula dengan mengkaji masalah semasa yang berlaku terhadap reka bentuk bagi kit latihan automasi mudah alih dalam pemasaran. Kemudian langkah seterusnya adalah dengan mereka bentuk model kit latihan automasi mudah alih dan melakukan pembangunan konsep model melalui enam proses termasuk proses percambahan fikiran, *house of quality*, konsep reka bentuk, meja morfologi, pokok objektif dan akhir sekali iaitu kaedah objektif berwajaran untuk menjana akhir reka bentuk model. Selepas itu, integrasi terhadap model prototaip telah dilakukan, sesi dokumentasi dan akhirnya penambahbaikan bagi reka bentuk prototaip telah dilakukan selepas mengenal pasti masalah yang telah berlaku pada model.

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LIST OF SYMBOLS

$\sum F_x$ = Summation force at the x-axis

$\sum F_y$ = Summation force at the y-axis

$\sum M_0$ = Summation of moment

W = Weight

m = Mass

g = gravity

θ = Degree

LIST OF ABBREVIATION

PLC	=	Programmable Logic Control
USA	=	Understand, Simplify, and Automate principle
GM	=	General Motor
CIM	=	Computer-Integrated Manufacturing
CAD	=	Computer-Aided Design
SLDC	=	Software Development Life Cycle
CPU	=	Central Processing Unit
CATIA	=	Computer Aided Three Dimensional Interactive Application
LED	=	Light Emitted Diode

CHAPTER 1: INTRODUCTION

1.0 BACKGROUND PROJECT

The idea of design a portable automation training kit is to enhance the understanding of a particular automation system which has been programmed by using module as a model to display the process of learning that is connected with Programmable Logic Controller (PLC) and power supply during training sessions.

A portable automation of training kit should be provided to engineers, technicians, machinist and university or college students to indoctrinate them usage and understand about the function of system through this application. The PLC is often covered by undergraduate in technical studies through control-related courses. Moreover many educational institutions still lack of resources to help students to become proficient in programmable logic controller users due to high of student ratios, limited access to labs, and limited equipment to support lab assignments (Hsieh, 2004).

During training sessions, training kit should be provided complete with modules which has been programmed according to a particular system, PLC, power supply, and together with other components while presenter can do demo on how does automation works and runs so that students can understand the application of the system easily. They will train about automation, PLC, and understand that concept, knowledge and theory related to the automation industry. The student will provide an opportunity to look through the running process of automate machine and understand the relationship how they coordinated with each other to form a process of the system.

This portable design of automate machine not just can be widely used on training courses for industry, it is also can be used as education equipments for high education institute for lab session and provide opportunity for student learn about automation. According to comparison between current design of training kit in market, there still lack of portability. Trainer need to carry the heavy automated training kit that will burden them to bring it for the learning purpose. Besides, automation involving a lot of mechanical elements and electrical elements so in this case new invention of training kit provided during training session should be as low as could that make trainee more understand the application of automation in the machine. Moreover there are many electrical parts should be coordinated by stager in PLC to overcome the problem arise while handling the devices.

Thus there is need ease of installation factors and how arrangement of every training kit component installed according to their own functional availability which has putted in the briefcase. The most important part design selection is on how the projection of module need to display to ease the viewers to see . Thus, to determine the final design of automation training kit, house of quality, morphological chart, weighted objective method, and Failure Mode and Effect Analysis (FMEA) were used. Then portable, feasible and usable factors would be applied to final design of training kit to show how does development process has been carried out.

1.1 PROBLEM STATEMENT

There are still lack of portable automation training kit in the industry and a lot of mechanical and electrical elements which take high costs to build. Moreover, the trainer needs to carry the heavy automated training kit for training purpose and lack of ease installation of the component when the display or doing demo to students. For an instance during automation system training session, the trainer needs to bring all the related components with different compartment for heavy PLC, power supply, wiring

elements and other component which is burdening him or her to carry on to anywhere. Thus, there is need integrated design of the portable training kit to help new stager to increase and ease their understanding of the automation system.

1.2 OBJECTIVE

The objective of this project basically is to develop a portable automation training kit design for training purpose.

1.3 SCOPE

A portable automation training kit project will be developed according to conceptual and selection method on design until the integration of the prototype. Scope for this area including on:

1. Study on state of the art automation training kit.
2. Total design approach on portable automation training kit.
3. Prototyping of selected concept.
4. Evaluation of prototypes based on their portability, usability and feasibility.

1.4 HYPOTHESIS

The study will examine the questions and issues interconnected to one another as described as follows:

- How to design the portable automation training kit and how does prototyping process will be implemented?

CHAPTER 2: LITERATURE REVIEW

2.0 INTRODUCTION

In order to upgrade the technical skills in this rapid advance technology, automation training kit developed a fully equipped training program to impart professionally designed in industry which is to ease trainer to bring them regarding on training purpose (SMC Pneumatics, 2012).

While a portable automation of training kit is to train about the particular application system which has programmed into the modules. The operation process of this application plays when a module connected to a board which has attached in a briefcase then it would run to the power supply. While from the power supply connector it would apply to a programmable logic controller (PLC) which is controlling the input or output for the module operation system. Training kit assists one to exploit the potential of most advanced product and to achieve the productivity and efficiency one desires. The equipments also allow hands on training for people for industrial automation.

Automation is the use of machines, control systems and information technologies to increase the productivity in production for supplies and delivery of services. From this training kit design, it is used artistically of automation system that have in industry to indoctrinate the usage for students completing their tasks regarding this subject which is then used simulation technique as the imitation of the operation process during automation system training session.

Automation can be generally defined as the process of following a predetermined sequence of operation with little or no human intervention, using specialized equipment and devices that control and perform manufacturing processes. Automation is important in the role of industries because it offers high throughput, consistent product quality, precise and repeatable production processes to accommodate new products and high adaptable production systems to allow frequent model changes (Saimon, 2008).

Therefore there are needs through training kits to show or to expose graduate and undergraduate students to the latest developments in hardware, software, and related protocols for power automation.

2.1 DESIGN

Designing an automation training kit needs a lot of consideration factors throughout the process. This is because there are needed conceptual design of every component such as how does the module's compartment to be placed, what is the suitable types of pin connector, programmable logic controller and power supply to be implemented. According to Dieter and Schmidt (2009) design is the form, parts, or details of something according to a plan. Total design includes the activity of market investigation of training kit, conceptual design, product evaluation and prototyping the final design which has selected (Tan, 2010).

The design consists of the visual patterned characteristics embodied in, or applied to, a piece of manufacture (A Guide to Filing A Design Patent Application, 2012). Given the breadth of the component space, the design must be carefully planned to take advantage of the diverse set of possibilities (Kurtoglu, 2007).

Good design requires both analysis and synthesis. Analysis is to perform services that are able to calculate as much about the parts' expected behavior as possible before it exists in physical form by using an appropriate discipline of science, engineering and the necessary computational tools. While synthesis involves the identification of the design

elements that will comprise the product, its decomposition into parts, and the combination of the partial solutions into a total work system (Schmidt, 2009).

There is need conceptual design or conceptualization in the beginning phase of the design process normally after the recognition of the need. There would be creating the creativity in conceptualization as it identifies many alternative solutions (Sapuan, 2005). Besides that, design process would bring to the problem solution and ideas generation. According to the design phase can be simply described to include the conceptual design brief and the creating initial design concepts in example developing the design once the concept has been approved (Rohana, 2008). In this case the conceptual design stage was the third step activities after market analysis and product design specification (Sudin, 2005).

Therefore, there is some generation of conceptual design process would be considered as shown in **Figure 2.1**. These processes have considered many types of operational process for the portable automation training kit. There are some new designs of body, sizes, materials and costs to generate the new invention of automation training kit.

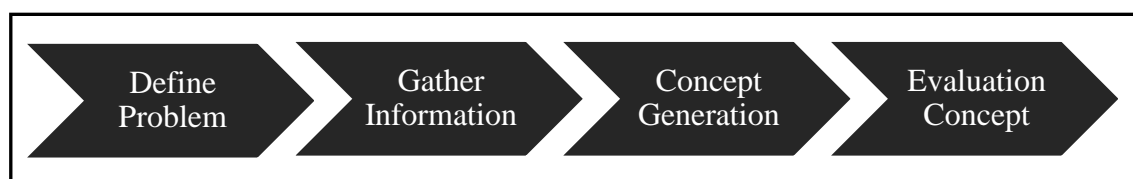


Figure 2.1: Generation of conceptual design (Schmidt, 2009)

Generation of conceptual design requires problem definition which concise the issues of problem statement and does the comparison processes to get the best one. After the problem statement striking improvements some information such as internet, technical articles or trade journals would be needed to gather more information especially in the automation industry.

Moreover, creativity methods such as brainstorming process, functional models or systematic design in the industry could discover the concept generation. This process has proven that to concise the concept development there are require initiation process which are mind mapping, analogy of design product, brainstorming process, morphological chart and also the selection concepts of design matter (Sudin, 2005). Finally, there will be done with decision making and criteria selection for every concept that has been discussed.

Thus, to design automation training kit a lot of ideas to optimize the conceptual design. It would use Computer Aided Three-dimensional Interactive Application (CATIA) to generate the conceptual design and to estimate the dimension for each component which has selected. This application enables improvement in design selection of training kit. During optimization, begin designing the solution by evolving the solution concept as it will be in the final application. In this study, there will learn also on how to evaluate the optimized processes and validate the conceptual design that has been done (Optimizing the Conceptual Design, 2012).

2.1.1 Computer Aided Design (CAD)

Computerized in Manufacturing System (CMS) to mid volume manufacturing industry have become an important new step in the development of automated manufacturing which are aimed to reduce the amount of manual and clerical effort in product design, manufacturing planning and control, and the business functions. There are also come with integrates of computer-aided design (CAD) and computer aided manufacturing (CAM) in CAD/CAM (Chen, 1982).

The first CAD systems were developed by for extensive engineering and software users. In the late 1950's and early 1960's, airport most early users were defense contractors in the aerospace and electronics industry in craft and automobile companies, where the U.S. Department of Defense are very complex, developed their own (DOD)

supported CAD development and use software to aid in product design and engineering. Pioneer user which is GM has done with the formal market for the purchase and sale were necessarily large firms because early of CAD emerged during the 1970's, due in part CAD and engineering field (Lynch, 1982).

Creation of a CAD/CAM team at Dassault Aviation (Bernard, 2003):

1. To develop master geometry software
2. To create the outer shape of the airplane
3. To deliver external shape data to design & manufacturing

2.2 AUTOMATION

Study on automation plays an important role in the industry. Automation defined as a technology that dealing with the application of Mechatronics and computers for the production of goods and service (Kumar, 1999). Moreover automation acts to replace human manual control, preparation and problem solving with automatic devices and computers (Lisanne, 1983). Thus automation system has increased the production of a product or even in services according to the customer requirement.

Why automation? Weber (1988) evaluated that the most important reason is they are low-cost, powerful, and easy-to-use microcomputers make automation more accessible to user than previously. They are known as a series of machine tools, each doing one operation automatically, became linked in a continuous production line of pneumatic or hydraulic devices transferring components from one operation to the next stage.

Besides that, there is another major automation product segment to achieve. This breakthrough innovation was the brainchild of the prolific and perennial inventor Dick Morley, who worked for a small development company, Bedford Associates, associated with Modicon (now part of Schneider). Also involved was Odo Struger of Allen-