DESIGN OF REMOTE SYSTEM CONFIGURATION FRAMEWORK IN MANUFACTURING ENVIRONMENT

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Robotics & Automation) (Hons.)

by

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APPROVAL

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

.....

(DR. MUHAMAD ARFAUZ BIN A RAHMAN)

ABSTRAK

Jangka hayat produk yang lebih pendek telah membawa kepada perubahan pesat dalam kaedah menghasilkan produk. Salah satu kaedah adalah termasuk mengkonfigurasi susun atur pembuatan dengan teknik yang berbeza. Teknik ini adalah sebahagian daripada konsep sistem pembuatan pembentukan semula (RMS). RMS adalah satu konsep yang praktikal yang boleh ditempatkan untuk mengatasi masalah ini. Dalam usaha untuk melengkapkan isu ini, projek ini dicadangkan pendekatan konfigurasi jauh daripada sistem pembuatan semasa. Pendekatan konfigurasi jauh merujuk kepada program khusus untuk menyusun komponen sistem pembuatan tanpa keperluan penglibatan langsung jurutera di tapak. Idea utama projek ini adalah untuk mereka bentuk rangka kerja konfigurasi sistem jauh dalam persekitaran pengeluaran yang ditetapkan. Projek ini memberi tumpuan kepada industri makanan dalam tin sebagai persekitaran pembuatan yang dipilih. Konfigurasi sistem pembuatan dalam industri makanan dalam tin adalah satu proses yang mencabar. Rangka kerja yang direka akan digunakan untuk mengurangkan masa konfigurasi susun atur yang menjejaskan keseluruhan masa aktiviti pembuatan dalam industri makanan dalam tin. Keadaan ini kadang-kadang juga biasanya disebabkan oleh salah faham dan maklumat yang tidak tepat yang dipindahkan antara jurutera dan juruteknik di lantai pengeluaran. Sebelum proses reka bentuk rangka kerja ini, kajian mengenai proses semasa melibatkan dalam pengeluaran industri makanan dalam tin telah dijalankan. Kajian ini merangkumi kajian tentang pendekatan reka bentuk pelbagai kepada konfigurasi susun atur. Empat jenis makanan dalam tin telah dipilih dalam kajian ini yang merangkumi sardin dalam tin, ham tin, sup dalam tin dan nanas dalam tin. Proses reka bentuk rangka kerja yang melibatkan penggunaan perisian CATIA untuk melukis komponen dan Visual Basic untuk pengaturcaraan dan pengantaramukaan sistem. Hasil daripada projek ini adalah satu rangka kerja konfigurasi sistem generik ya.ng mampu menyediakan reka bentuk susun atur yang sesuai bagi industri makanan dalam tin

ABSTRACT

Shorter product life span has lead to a rapid change in the aspect of method to produce a product. One of the methods includes configuring the manufacturing layout in a different technique. This technique is part of reconfigurable manufacturing system (RMS) concept. RMS is a practical concept that can be accommodated to overcome the issue. In order to complement the issue, this project proposed the remote configuration approach of the current manufacturing system. Remote configuration approach refers to a specific program with an interface that is able to arrange the manufacturing system components without the needs of direct involvement of engineer on site. The main idea of this project is to design a remote system configuration framework in a specified manufacturing environment. This project focuses on the canned food industry as the chosen manufacturing environment. Configuring manufacturing system in canned food industry is a challenging process. The developed framework will be used to reduce the layout configuration time that arose which affect the manufacturing lead time in canned food industry. This situation is sometimes also commonly caused by misunderstanding and inaccurate information being transferred between engineer and technicians in the production floor. Prior to the design process of the framework, a study on the current process involves in the production of canned food industry has been conducted. This study includes a review on various design approaches on layout configuration. Four types of canned food have been chosen in this study that includes canned sardines, canned ham, canned soup and canned pineapple. The design process of the framework involved the use of CATIA software for drawing the components and Visual Basic for the programming and interfacing of the system. The outcome of this project is a generic system configuration framework that able to provide suitable layout design for canned food industry.

DEDICATION

This bachelor degree project report has been dedicated to my beloved parents, as well as my project supervisor and university faculty.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

3D	-	Three Dimensional
ANSI	-	American National Standards Institute
BOM	-	Bill of Material
CAD	-	Computer-Aided Design
CATIA	-	Computer Aided Three-dimensional Interactive Application
COM	-	Component Object Model
DMS	-	Dedicated Manufacturing System
DP's	-	Design Parameters
FMS	-	Flexible Manufacturing System
FR's	-	Functional Requirements
GUI	-	Graphic User Interface
HeGeL	-	Heuristic Generation of Layouts
IDE	-	Interactive Development Environment
LAN	-	Local Intranet
PDF	-	Portable Document Format
PNG	-	Portable Network Graphics
RAD	-	Rapid Application Development
RMS	-	Reconfigurable Manufacturing System
RMs	-	Reconfigurable Machines
RMT	-	Reconfigurable Machine Tools
SCoM	-	System Configuration of Manufacturing
SVG	-	Scalable Vector Graphics
SVN	-	Subversion
UI	-	User Interface
UML	-	Unified Modeling Language
UX	-	User Experience
VB	-	Visual Basic
WIP	-	Work In Process
XML	-	Extensible Markup Language

CHAPTER 1
INTRODUCTION

1.1 Background

In a manufacturing environment, a system exists for the purpose of good interaction and cooperation between human and machines to perform a task. System has been defined in Oxford dictionary (Oxforddictionaries.com, n.d.) as a set of things that work together as parts of a mechanism or an interconnected network. In order to allow good interaction between all elements involved in manufacturing environment, such as machines, tools, humans, information and materials, arrangement of all these elements should be designed in sequence (Koren, Jack, and Thomas, 1998). The arrangement of manufacturing elements in a specific form or combination is known as system configuration (Koren, 2010). The system configuration requires a basic framework to support the functionality of a system. Humans create hundreds ways of designing the system configuration framework to enhance the efficiency and effectiveness of activity in manufacturing environment (Drira, Pierreval, and Hajri-Gabouj, 2007).

Traditionally, system configuration has been classified into three main types. The first type is classic machining system, second type is flexible manufacturing system (FMS), and the third type is dedicated manufacturing system (DMS) (Eldardiry, Alkadeem, and Sabry, 2012). Nowadays, due to short product life span trend in current manufacturing industry, the reconfigurable manufacturing system (RMS) has been introduced (Landers, Min, and Koren, 2001). In simple words, RMS allows the

system to be updated due to the improvement or innovative on product variety. As the system kept on reconfigured to adapt appropriate system for new developed product, manufacturing system design becomes more frequent to use. Designing a manufacturing system has been related to important system characteristics such as operational cost, product volume, product variety, product quality, and system flexibility. All these system characteristics have been taken into consideration by the system designer as reconfigure manufacturing system.

Information is one of the essential elements in designing the system configuration framework. The accuracy of information flow throughout the system or process would determine the performance of manufacturing activities as well. In designing system configuration framework, the equipment selection, equipment location arrangement, work design, material and information flow would be the important information to be transferred from system designer to people responsible in arranging the system physically (Cochran, Arinez, Duda, and Linck, 2002).

With the advancement of technology, new method has been emerged in data information sharing. The method allows the information being transferred remotely. The term “remote” is known as an adjective word used in describing operating at a distance for an electronic device or gadgets. Information sharing using remote system allow anyone that in distant with source getting in touch and up-to-date with the information. Remote system is seems as the potential approach to be used in manufacturing system for the purpose of information flow control and arrangement. This project has discovered and verified this possibility.

1.2 Problem Statement

Demand for variation of product has been a popular need among consumers. This need has given large impact to manufacturing industry, such as canned food industry.

For canned food industry, product variety has been difference in terms on the ingredients of food, shape and size of can, type of labeling and packaging sequence. Canned food manufacturers have to consider all of these factors in reconfiguring their manufacturing system. As the manufacturing system keep on being reconfigure when new product introduced, information on designed manufacturing layout should be conveyed to the production department. Accurate information allows the production technicians to setup the layout for manufacture related product. Thus, information transfer is an important part to ensure correct and accurate information being passed to technicians that responsible to setup the production line.

In this case, the manufacturing layout design of canned food industry, along with the list of required machines and tools are the information that connects both engineer and technician. Technicians require detailed guidance of setting up the manufacturing layout of canned food production from engineer. It would be very difficult for technicians to get detailed information when the engineer is at offsite area. If the information given by engineer is not complete, it would cause a misunderstanding on the changing of manufacturing layout. Misunderstanding on information would also cause prolong of layout setup time. Engineer or experts on layout design is required to be presence at site to provide guidance verbally. However, verbal instruction may provide similar results and sometimes becomes worse if the instructions are not clear or poor understanding by technician of the given instructions.

In this project, transferring the information remotely is seen as a good method to convey the necessary information. In this method, the information related to new configured manufacturing system can be transferred in a simple and specific guidelines or instructions. The instructions may come in together with visual aid with correct labeling. The instructions should be made simple to known even without the explanation from engineer or expert on layout design.

1.3 Research Objectives

Manufacturing system configuration in canned food industry is a challenging process in ensuring shorter manufacturing lead time. Problems occurred during configuration due to misunderstanding and inaccurate information being transferred between engineer at offsite area and technicians at the production floor. In order to overcome the issues mentioned in canned food industry, following are the objectives that have to be achieved:

i. To study the current process in production of canned food industry.
ii. To study the design approach on layout configuration in manufacturing environment, especially in canned food industry.
iii. To design a remote system configuration framework for production of canned food industry.

1.4 Research Scope

The proposed remote system configuration framework is to be applied in canned food industry. The proposed framework will involve only four types of canned food products. The four types of canned food products selected in this research are pineapple, sardines, ham and bean soup. Each canned food products can be filled into different shapes of can. The following are suggested shapes of can that most suitable for each canned food products:

i. Pineapple with cylindrical can
ii. Sardines with rectangular can
iii. Ham with oval can
iv. Bean soup with trapezoidal can

Each type of shapes can be classified into different sizes. Different sizes of can would affect the volume or net weight of food to be filled into the can. The sizes of can in this project is reviewed from the existing can size used in market. Following are the three sizes for each shape of can that consider in this project, which are:

i. Large
ii. Medium (optional due to only two sizes of can for the respective shape)
iii. Small

The proposed system would design the manufacturing system layout based on the chosen shape and size. Manufacturing system layout and list of machines are the required information output from the proposed system.

The study on manufacturing process has to be done ahead in order for manufacturing system design. This study is carried out by searching material resources including the internet sources, articles and journal of related field. Manufacturing layout of the canned food production for each dimension of four different products is drawn by using CAD software, such as CATIA. The program is written in Visual Basic software. Both CAD software and system programming are connected through the graphic user interface (GUI).

CHAPTER 2
LITERATURE REVIEW

This chapter discusses the literature review on specific topics related to configuration of manufacturing system layout, approaches on designing a manufacturing system layout, tools in designing manufacturing system layout, and processes involved in specific canned food industry.

2.1 Configuration of Manufacturing System Layout

Manufacturing is a process of utilizing equipments and labour in making product for usage or market sale (Sirca, 2008). Industry manufacturing also refers to set of activities that transform raw materials into finished goods. All these activities have to be arranged in a sequence to ensure efficiency and effectiveness in making the right products. Throughout the historical industry revolution, there are four basic classification of manufacturing system (Eldardiry, Alkadeem and Sabry, 2012). There are classic machining systems, dedicated manufacturing systems, flexible manufacturing systems, and reconfigurable manufacturing systems. The focus of this project is much related to reconfigurable manufacturing system. This manufacturing system is design based on basic modules arranged efficiently and effectively.

2.1.1 Reconfigurable manufacturing system (RMS)

In the 21st century, manufacturing companies have been introduced to a manufacturing system known as reconfigurable manufacturing system (RMS). The reason of RMS being introduced is due to the high rate of market changes that caused by the global competition (Koren and Shpitalni, 2010). Market changes are referred to the changes in product demand, changes in existing products, and introduction of new products. In order to ensure competitiveness of company in the global market, all the manufacturing companies have to adapt to the market changes, product changes, and system failures. In another words, the manufacturing companies have to be responsive rapidly to market changes and consumer needs, aside the focus on high throughput and high quality product with low cost.

RMS is a cost effective manufacturing system that able to response to rapid market changes. It consists of three features that allow the manufacturing system able to adapt to frequent changes. The three features that have been introduced in this manufacturing system are capacity, functionality, and cost. RMS is not constrained by these three features, whereas by scaling on these features allow RMS be a responsive manufacturing system. A responsive manufacturing system that allows production capacity to be adjusted according to the fluctuations of product demands. It also allows the functionality of production line to be adapted in manufacturing of new products.

Based on Koren (2006), RMS followed two principles:

i. Design adjustable structure on a system and its machines to allow system scalability in response to product demands and adaptability of system or machine to new products. Adjustable structure can be build at the system level and/or the machine level.
ii. Design a manufacturing system that allows customized flexibility on producing all parts within the part family.

In general, RMS can be defined as a manufacturing system designed to adapt rapid changes in both software and hardware components, by adjusting production

capacity and functionality for a product family, as accommodate to regulatory requirements or sudden market changes (Koren and Shpitalni, 2010 ; Koren et al., 1999 ; Koren, 2006 ; Sirca, 2008).

2.1.2 Key characteristics and principles of RMS

There are six configurable characteristics have been embedded on RMS, which are summarized as follows (Koren and Ulsoy, 2002):

i. *Customization* – Ability on customized flexibility of system or machine that limited to a single product family.
ii. *Convertibility* – Ability on easy changing the functionality of existing systems and machines to adapt to new production requirements.
iii. *Scalability* – Ability on easy modifying the production capacity of existing system by adding or subtracting manufacturing resources and/or changing components of the system.
iv. *Modularity* – Ability on divide operational functions into section units that can be manipulated between alternate configurations for optimal arrangement.
v. *Integrability* – Ability on combine modules rapidly and precisely by a set of informational, mechanical, and control interfaces that facilitate integration and communication.
vi. *Diagnosability* – Ability on identify current status of system automatically to recognize and diagnose the root causes of output failures, and perform correction on failures quickly.

The relationship of six core characteristics with the RMS goals of enhancing responsiveness and productivity, as well as reducing life-cycle cost are shown in Figure 2.1. The figure shows the relevance of determined core characteristics in suit to achieve the goals.