DEVELOPMENT OF CONCEPTUAL JIG AND FIXTURE FOR THE TIE PLATE USING INTEGRATED FMEA AND AHP APPROACH

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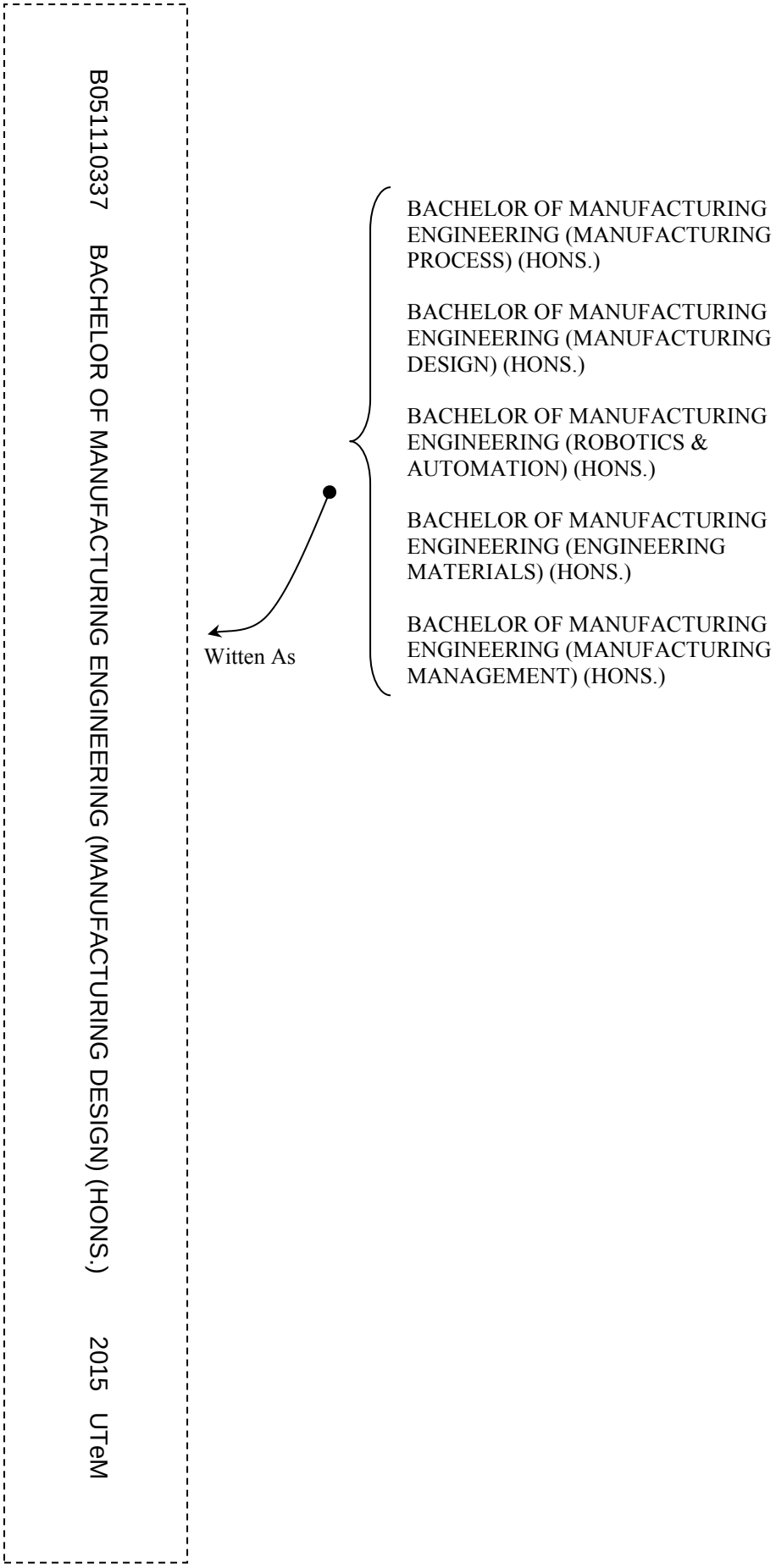

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This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Design).

by

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Development of Conceptual Jig and Fixture for The Tie Plate Using Integrated FMEA and AHP Approach**

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design). The member of the supervisory committee is as follow:

.....

Supervisor

ABSTRAK

Projek ini membincangkan tentang aplikasi mengintegrasikan FMEA dan AHP dalam pembangunan reka bentuk konsep jig dan lekapan untuk "tie plate". Objektifnya adalah untuk memilih reka bentuk konsep terbaik menggunakan integrasi baru FMEA dan AHP supaya boleh digunakan di bahagian proses hentakan di dalam automotif (dikenali sebagai "tie plate") industri pembuatan. Projek ini memberi tumpuan kepada mengurangkan bilangan proses, masa, dan tenaga kerja dengan melaksanakan pendekatan integrasi yang dicadangkan. FMEA telah digunakan untuk mengenal pasti kegagalan jig dan lekapan, memungkinkan untuk mendapatkan ranking punca kegagalan yang merangkumi beberapa jenis maklumat (kadar kegagalan, bukan pengesanan, keterukan, kos dijangka bagi setiap kesalahan). Tindakan yang disyorkan FMEA diambil dan dianalisis untuk menjana empat konsep reka bentuk dengan kaedah analisis morfologi dari segi lakaran. AHP yang berlaku dalam membina matriks perbandingan berpasangan digunakan untuk menentukan konsep reka bentuk terbaik jig pembungkusan sebagai pelbagai aspek perlu diambil kira dalam pemilihan seperti prestasi, penyelenggaraan, kos, keselamatan dan punca potensi kegagalan. Hasil kajian menunjukkan bahawa konsep 4 (32.3%) telah dipilih sebagai salah satu konsep yang terbaik untuk meningkatkan proses pembungkusan dan boleh menyumbang kepada pengurangan masa dan kos serta tenaga kerja. Dengan menggunakan perisian reka bentuk SolidWorks 2013, konsep terakhir diambil dalam bentuk pemodelan 3D dan analisis yang dijalankan untuk membuat perbandingan antara dua jenis bahan ABS dan Galvanize. Keputusan analisis menunjukkan bahawa ABS adalah bahan yang sesuai digunakan dalam pembuatan jig untuk plat tie pembungkusan. Kajian ini membentangkan kepentingan mempertimbangkan pendekatan yang bersepadu bagi meningkatkan aktiviti proses pengeluaran, terutamanya dalam industri bahagian stamping automotif.

ABSTRACT

This project is about application of Integrated Failure Mode Effect Analysis and Analytic Hierarcy Process in development conceptual design jig and fixture for tie plate. The objective are to select the best concept design using propose a new integration of the FMEA and AHP so that can be used in the automotive stamping part (known as tie plate) manufacturing industry. This project focuses on reduce the number of processes, time, and labour by implementing the proposed integration approach. FMEA was used to identify the failure of jig and fixture, makes it possible to obtain a ranking of failure causes which includes several types of information (failure rate, non-detection, severity, expected cost for each fault). The recommended action of FMEA is taken and analysed to generate four design concepts by morphological analysis method in terms of sketch. The AHP take place in constructing the pairwise comparison matrix was used to determine the best design concept of the packaging jig as variety of aspects have to be considered in the selection such as performance, maintenance, cost, safety and potential cause of failure. The results showed that the concept 4 (32.3%) was selected as one of the best concepts for improving packaging process and can contribute to the reduction of time and costs as well as labor. By using design software of SolidWorks 2013, the final concept is drawn in the form of 3D modelling and the analysis is conducted to make a comparison between two types of material ABS and Galvanize. The results of the analysis show that the ABS is an ideal material used in the manufacture of jigs for the packaging tie plate. This research presents the importance of considering the integrated approach in order to improve the manufacturing process activities, especially in the automotive stamping parts industry.

DEDICATION

Special thanks to my beloved familys for their support with my studies. Thank you very much for giving me a chance to improve myself through all my life. To my lecturer and my friends, thank you so much for guided and teach me.

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3D	-	Three Dimensional
AHP	-	Analytical Hierarchy Process
ANP	-	Analytic Network Process
CA	-	Criticality analysis
CAD	-	Computer Aided Design
CI	-	Consistency index
CR	-	Consistency ratio
D	-	Detection
DA	-	Decision Alternatives
DM	-	Decision Maker
DFMEA	-	Design Failure Mode and Effect Analysis
FMEA	-	Failure Mode and Effect Analysis
I^R	-	Inconsistency Ratio
O	-	Occurrence
P_o	-	Potential Causes
P_d	-	Effect of Failure
PFMEA	-	Process Failure Mode and Effect Analysis
PSM	-	Projek Sarjana Muda
RPN	-	Risk Priority Number
RI	-	Random index
S	-	Severity
S	-	Failure Mode
UTeM	-	Universiti Teknikal Malaysia Melaka
λ max	-	Maximum Eigen value

CHAPTER 1
INTRODUCTION

This chapter provides about the background of the project. The project focuses on the development of conceptual jig and fixture for the Tie Plate using integrated FMEA and AHP approach. This chapter also describes the problem statement, objective and scopes of the project.

1.1 Background

Nowadays, technology grows rapidly. Manufacturing sector, particularly affected by this situation to support production to meet higher consumer demand. In the product development process, engineers as an important role in finding new ideas, in order to solve the problems faced by the workers. Mass production is intended to increase productivity in order to reduce the unit cost of the product. Therefore, to achieve goals those require tools to support the production and fulfil the market demand.

In manufacturing works, a jig is a type of custom made tool used to locate and guide the workpiece. The purpose of a jig is to provide repeatability, accuracy, and interchangeability in the manufacturing of products (Henriksen and Erik Karl, 1973). The use of jigs and fixtures is similar and related that the terms are sometimes confused or used interchangeably. The difference is in the way the tool is guided to the work piece.

A jig is a special device that holds, supports, or is placed on a part to be machined. The jig is not only locates and holds the workpiece but also guides the cutting tool while the operation is performed. Jigs are usually equipped with hardened steel

bushings for guiding drills or other cutting tools (Hoff man, 2011). A fixture is used for locates, holds, and supports the work securely so the required machining. Another tool such as set blocks and feeler or thickness gauges are need used with fixtures as reference the cutter to the workpiece (Hoff man, 2011). There are many types of jigs, every type is custom made to do a specific job. Many jigs are created because there is a necessity to do so by the tradesmen. Some are made to increase productivity through consistency, to do repetitive activities or to do a job more precisely (Hoff man, 2011).

Tie plate is one of the automotive parts that are placed in CamPro engine for proton cars. Tie plate is a product resulting from the stamping process. The function of tie plate is to divide the piston holes found in a car engine before casting process. Means the tie plate will be part of the engine block after casting process is done. Because the engine is an important and requires high accuracy, so the quality of flatness of tie plate is very important and emphasized during the manufacturing process.

Thus, this study discussed about the application of tool failure mode effects and analysis (FMEA) is applied in designing the concept. FMEA then should include the activities at both design and manufacturing stages that will cover both design and production. Usually, this analysis is conducted in the early stages of the product life cycle which is common and critical.

In this project, FMEA is a tool to select the best design concepts at the conceptual design stage in the product development process. At this stage of conceptual design the best tool to implement is the Analytic Hierarchy Process (AHP). According to Bevilacqua and Braglia (2000), the AHP is a powerful and flexible multi criteria decision making for complex problems that considers the qualitative and quantitative aspect. The application of AHP is related to evaluating and selecting different alternative besides selecting the best design concept at the conceptual design stage. Thus, this will lead in achieving a high quality product and shorter product development process instead of reducing the cost.

1.2 Problem Statement

The problem examined in this study is related to process problems in the stamping part for tie plate. Multi-criteria decision making can be used to consider the other factor in the consideration. The idea of the integration FMEA and AHP was realized by previous researchers to recover the drawback of FMEA system due to reduce the number of processes, time and labor by identifying and reducing the failure in the existing stamping process. Braglia (2000) and Carmigani (2009) stated that the factor of failure was never considered the economic issue in the FMEA evaluation.

1.3 Objective

The aim of the project is to design the conceptual jig and fixture for the Tie Plate using integrated FMEA and AHP approach.

Specific as follows:

a) To identify the failure mode in the current conceptual design of jig and fixture using FMEA approach.
b) To select the best design of conceptual jig and fixture for stamping part using AHP approach.
c) To minimize the stamping process of fabricating tie's plate.

1.4 Scope Of Project

This project focuses on developing conceptual jig and fixture for the Tie Plate. Therefore, the integrated FMEA and AHP will be applied to the conceptual design to develop the conceptual jig and fixture. The research is to identify failure design using FMEA (DFMEA) and selected the best design concept using AHP.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter consists all the data and information which related to study about development of conceptual jigs and fixture for the Tie Plate using integrated FMEA and AHP approach.

This chapter also discussed about jigs and fixtures, FMEA also AHP as method in this project. In addition, product design and development method is described for concept selection of jig. Finally, Software SolidWorks is described as a tool for design in solid modelling 3D and analysis for selected conceptual jig.

2.2 The Failure Modes and Effect Analysis (FMEA)

Failure mode and Effect Analysis is a systematic, proactive method for evaluating a process to identify where and how it might fail and to assess the relative impact of different failures, in order to identify the parts of the process that are most in need of change (Institute Healthcare Improvement, 2004). It is known as a design tool that has been around for many years and is recognized as an essential function in design from concept through to the development of every thought type of equipment.

The purpose of the FMEA is to prove that the worst case failure in practice does not exceed that stated by the designers in the functional design specification. Ideally, the FMEA should be initiated at as early a stage in the design process as possible and then run in parallel with the design phase. Many types of failure mode have been

revealed by an FMEA, each having different failure effects on the overall system form ones of solely nuisance value to others that could have resulted in events of disaster proportion if left undetected. This is due to the searching nature of the FMEA process (The International Marine Contractor Association, 2002)

2.2.1 Type of FMEA / FMEA in identifying cause of failures

FMEA is performed to identify causes of failures affecting the reliability of the product such as the product function, failure, effect of failure and the consequences of failure. FMEA is often conducted to clarify the correlation between causes of failure on component level and corresponding causes of failure on system level, and to obtain an arrangement to avoid causes of failure or reduce the consequences of failure.

The accuracy of the result is dependent on the amount of information and how detailed the information is (Pavasson and Karlberg, 2011). To enable identification of causes of failures and to be able to study the influences of failures, FMEA has been further developed into the two major methods. The first method is called Design Failure Mode and Effect Analysis (DFMEA) and is used to analyse the failure mode for the design while the second method is Process Failure Mode and Effect Analysis (PFMEA) which used to analyses the failure mode for a process (Pavasson and Karlberg, 2011).

One result from FMEA is a Risk Priority Number (RPN) which pointed based on subjective ratings on a 1-10 scale. The RPN is calculated by the mathematical product of the three criteria that are Potential causes *(Po)*, Failure mode *(S)* and Effect of failure *(Pd)*.