STUDY THE ATTRIBUTES OF PRODUCTS AND PROCESSES FOR AUTOMOTIVE PRODUCT DEVELOPMENT: CASE STUDY OF AUTOMOTIVE CAR'S ENGINE

NUR ATIKA BINTI ZUKFFLAY@ZULKIFLI
B051110278

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 (Manufacturing Design) (Hons.)

by

NUR ATIKA BINTI ZUKFFLAY @ ZULKIFLI
B051110278
920106-08-5930

FACULTY OF MANUFACTURING ENGINEERING
2015

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Study the Attributes of Products and Processes for Automotive Product Development: Case Study of Automotive Car's Engine**

SESI PENGAJIAN: **2014/15 Semester 2**

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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) (Hons.). The member of the supervisory is as follow:

……

(Dr. Suriati Binti Akmal)

ABSTRAK

Laporan ini menerangkan mengenai kajian terhadap enjin kereta dalam bidang automotif yang mengkaji ciri ciri produk dan proses untuk pembangunan produk automotif. Secara asasnya, perkembangan semasa terhadap teknologi enjin kereta telah menjadi satu penyelidikan yang penting dalam kalangan penulis pada masa lalu kerana terdapat pereka-pereka yang perlu untuk menghasilkan reka bentuk yang terbaik di masa akan datang. Walau bagaimanapun, maklumat daripada enjin kereta ini tidak diuruskan dengan teratur dan pengetahuan yang telah ada perlu diuruskan secara baik untuk mengurangkan masa proses reka bentuk. Oleh itu, kaedah yang dicadangkan untuk menyelesaikan isu ini ialah dengan menggunakan garis panduan yang sistematik iaitu Formal Attribute Specifications Template (FAST) untuk mengenal pasti ciri-ciri maklumat automotif secara domain. Ciri-ciri maklumat enjin kereta ini boleh digunakan dalam Formal Concept Analysis (FCA) untuk membangunkan ontologi terhadap enjin kereta yang mewakili pengetahuan secara domain dari segi kelas, unsur-unsur dan hubungan antara ciri-ciri dan proses. Akhirnya, hasil daripada ontologi ini iaitu kelas hierarki digunakan untuk menjalankan analisis kelompok untuk membandingkan persamaan antara setiap kelas dan ciri-cirinya.

ABSTRACT

This report describes the case study of automotive car's engine which to study the attributes of the products and processes for automotive products development. Basically, the current development of car engine technology has become an important research among the authors in the past since there is designers that need to produce the best design in the future. However, the information about the car's engine is not being managed properly and the knowledge need to be managed in order to reduce the design process time. Thus, to solve this issue, this project proposes the use of a systematic guideline which is Formal Attribute Specifications Template (FAST) to identify the attribute information about automotive domain. The attribute information can be used in Formal Concept Analysis (FCA) to develop the automotive car's engine ontology which represents the domain knowledge in terms of classes, elements and possible relations between the attribute and process. Finally, the result of this ontology which is class hierarchy is used to conduct the cluster analysis in order to compare relatively the homogeneous groups of results.

DEDICATION

I dedicate this report writing especially to my beloved parents and to my whole family. A millions of thanks to them as their full support, and also for my dedicated supervisor, Dr Suriati Binti Akmal, thank you so much for your valuable guidance and advice. Last but not least, I dedicate this to my friends and my special one for their support and understanding.

ACKNOWLEDGEMENT

Alhamdulillah, first of all I would like to express my gratefulness to Allah SWT because of his grace and merciful, the final year project has been completed successfully. I would like to thank to my dedicated supervisor, Dr. Suriati Binti Akmal for her valuable guidance and advice throughout completing this final year project. The supervision and support that she gave truly help the progression of this project. She inspired me greatly to work in this project. Her willingness to motivate and contributed tremendously to my project is very encouraging me to complete this project. Besides that, I would like to thank the authority of Faculty of Manufacturing for providing us with good facilities to complete this project. Last but not least, an honorable mention goes to our families and friends for their understandings and supports on me in completing this project. Without helps of the particular that mentioned above, I would face many difficulties while doing this project. The co-operation is much indeed appreciated.

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LIST OF ABBREAVIATIONS, SYMBOLS AND NOMENCLATURE

BEV	-	Battery Electric Vehicle
EV	-	Electric Vehicles
FAST	-	Formal Attributes Specifications Templates
FCA	-	Formal Concept Analysis
GUI	-	Graphic User Interface
HEVs	-	Hybrid Electric Vehicles
ICE	-	Internal Combustion Engine
ISO	-	International Standard Organisation
KMS	-	Knowledge Management System
PHEV	-	Plug-in Hybrid Electric Vehicle

CHAPTER 1

INTRODUCTION

1.1 Background

The competitiveness in the automotive industry is steadily increasing especially in the development of engines. The trend is towards more complex engine configurations in order to meet the increasing emissions legislation and fuel consumption requirements (Karagiorgis et al., 2007). Many problems arise when designing automobile engines (Dimopoulos et al., 2008). Since there are many different parts of engines that can be optimized and improved, it really takes time in consuming the task. Therefore, these wide ranges of applications in engine's component have been the focus of a lot of research (Mohammad et al., 2014).

Recently, the hybrid technologies have become an important research study in the last few years (Abdalla & Lubis, 2010). Researches in hybrid advancement have focused on the numerous kind of design's aspect, such as the components of the architecture, the engine's performance, fuel emissions reduction, material for vivid components, power electronics and motors and great power of batteries density (Mahapatra et al., 2008). For example, the phenomenon throughout the electric vehicle technology is to develop AC motor drive systems for the future generation that can minimize mass, weight, volume and maintenance (Takahashi & Noguchi, 2010).

Today's engineer should improve the design that meets the requirement of lower emissions for automobiles without need incurred in the increasing of the cost (Mahapatra et al., 2008). Apart from that, there is the case where product designers

have to design from the beginning rather than using and reuse the best design in the future development (Akmal et al., 2013).

Due to the many researches about the development of the automotive car's engine performance, there are gaps and affect faces by the engineer which the explosive growth of knowledge and the information are not being managed properly. As the knowledge continuously increasing from day to day, thus the information need to be categorized in a proper ways. Besides that, there is no formal representation about all the knowledge and information. The importance of this formal representation is to help the engineer reduce the design process time while doing their research about engines.

Currently, the use of ontologies for arranging knowledge on a concept basis has been reported in the literature (Olehschuk et al., 2013). Ontology is a formal knowledge representation model that uses mathematical logic towards disambiguate as well as to explain groups of things (Maidin, 2008). Ontologies illustrate a shared and also typical comprehension of the domain with respect to classes, potential relations amongst things as well as axioms which constrain the definition of classes as well as relations (Batres et al., 2007). The class mean group of things is shared similar characteristics. The relationship can be used in order to express the connection between the two or even more things. Samples of relations tend to be lower than, associated to, as well as a part of. Course taxonomies tend to be defined by the meaning of their respective subclass relation. The class is actually a subclass of some other class when each and every affiliate for the subclass is also a member for the super class. Axioms are usually represented just as logic constructions which formally describe the provided class or perhaps connection.

The established research proposed the use of ontologies which portray the domain knowledge in terms of classes, elements and feasible relations regarding the attribute and process that describe between the concepts (Yu & Hsu, 2011). Several applications prolonged from ontology have been introduced such as decision-making, knowledge of representation for automotive body assembly design (Zhang et al., 2009).

The main issue of this ontology is it is ordinarily constructed in an ad-hoc manner which the precision of the similarity calculations will be affected (Akmal et al., 2012). Apart from that, there is no guideline that shows the process of this ontology been doing. One of the approaches is the use of formal concept analysis (FCA) in which it is an analysis technique for knowledge processing that can be used to build ontologies (Haav, 2004). For example, keywords and FCA was used by S. S. Weng to build the ontology that relevant to keywords and data mining (Weng et al., 2006).

In this project, systematic method for identifying the attribute information about automotive domain is proposed. The attribute information can be used in the formal concept analysis in order to develop ontology.

1.2 Problem Statement

Nowadays, product development especially in automotive car's engine is growing progressively due to the complications of products and tremendously technological transformations (Akmal et al., 2013). There are many developments about the technology of engines such as the process, function and the material that can be found anywhere in websites, journals and books. Specifically, this information about the automotive engine's development needs to be managed as design teams face a considerable challenge in getting the proper information of the increasing knowledge. Besides that, there is no formal representation that shows the information of the hybrid electric vehicles in a proper way to be presented to help the designers reduce the design process time as the product designers can reuse previous designs of information rather instead of designing from the beginning. Typically, there is a lack of attributes definition in which a designer may not have complete knowledge and information about automotive engines (Akmal et al., 2012).

1.3 Objectives

The main objectives of the project are as follows:

a) To identify the attributes of products and processes for automotive product development by using FAST.
b) To develop the ontology of automotive engines.

1.4 Scope

In this research, the scope includes collecting the data about the technology involves in engine components and latest technology in engines which is hybrid system components. The parts of the engine will be categorized based on the attributes. The attributes are defined as the features or properties of the concept which guide the user to get the better understanding about the concepts within the ontology (Yu & Hsu, 2011). A tool called Concept Explorer is used to develop the concept lattice which is generated by means of the Grail algorithm (Yevtushenko, 2009). The information about object and attributes are saved in OWL language. This project uses an open source ontology editors and construction tools called Protégé created at Stanford University.

CHAPTER 2
LITERATURE REVIEW

2.1 Engine Technology

Manufacturers as well as engineers tend to be pursuing assorted ways of research towards their drive technologies without bounds within the future. Drive technology will likely be their decisive element in bringing regarding important adjustment in the future automobile industry. The continuous growth associated with the internal combustion engine has become consistent rather than spectacular, however, there is potential for lower fuel intake and for achieving it more environmentally friendly within the foreseeable potential future. Improvements in fuel injection technology tend to be increasing engine performance and shrinking damaging emissions. In addition, generally there tend to be signs for the traditional petrol engine might end up being wedded for the greater positive attributes of the diesel engine (Kaiser et al., 2008).

Among the challenges dealing with people designing the vehicle for the upcoming generation is actually the growth of environmentally friendly automotive technology. It consists of compact construction, latest drive principles, including hybrid engine system and fuel cells as well as renewable fuels such as biogenic fuels and hydrogen. One additional focus is actually in the growth of advanced driving assistance systems which are supposed to make driving much more delight and secure (Kaiser et al., 2008).

Throughout the last 15 years, the load of the typical family car has been increased by about 30%. The analysis of the latest vehicle registrations in Australia

demonstrates within years starting from 2000 to 2005, the load of the typical vehicle elevated by 11%. In spite of weight cut off inside engine blocks as well as bodywork created from light alloys, as modern cars tends to acquiring heavier material This might be occurring due to the improvement of latest electronic equipment in safety technology such as anti-lock braking system ABS, ESP, seat belt tensioners, active steering as well as four-wheel drive(4 WD). This might occur due to the raise comfort, and ease such as air-conditioning, automated electric windows and seats. However, the vehicle weighs influence the fuel consumption and more toxins it will be produce. Logically thinking, the reduction of vehicle's weight 100kg will lower fuel consumption by around 0.5 litres per 100 km. Simply by 2010, the reduction in vehicle weight is forecasted to be at 17%, which similar to an average 250kg per vehicle (Kotz et al., 2005).

Thus, manufacturers have mainly pinned their hopes on the light metal aluminium, because this substance has a low mass and does not rust. In the year 2000, about 100kg of aluminium were utilized in the manufacture of the average car, according to the European Aluminium Association. Due to scientific studies, magnesium is lighter than aluminium. This particular substance has a density of only 1.8 g/cm³. By contrast, aluminium weights 2.7 g/cm³ and steel just under 8 g/cm³. Magnesium is available in almost unlimited amounts and it will simply be processed and recycled. For these reasons, this light metal is becoming a preferred within lightweight construction materials. Figure 2.1 shows the crankcase made from magnesium on the right which up to 25% lighter than a comparable aluminium crankcase on the left (European Aluminium Association(EAA), 2007).

Figure 2.1: Crankcase (Kaiser et al., 2008)

2.1.1 Engines Classification

A heat engine classification as shown in Figure 2.2 is a tree, which transform heat energy into mechanical energy. The ignition of fuel such as coal, petrol and diesel generates heat. This particular heat is provided an operative substance at high temperature. Through the expansion of this substance in appropriate machines, heat energy is transformed into valuable work. Heat engines can be additional divided into two types which are external combustion and internal combustion as shown in Figure 2.3. In a steam engine, the ignition of fuel takes place outside the engine and the steam formed can use to run the engine. Therefore, it is recognized as an external combustion engine. When it comes to the internal combustion engine, the ignition of fuel takes place inside the engine cylinder itself (Hillagric,2008).

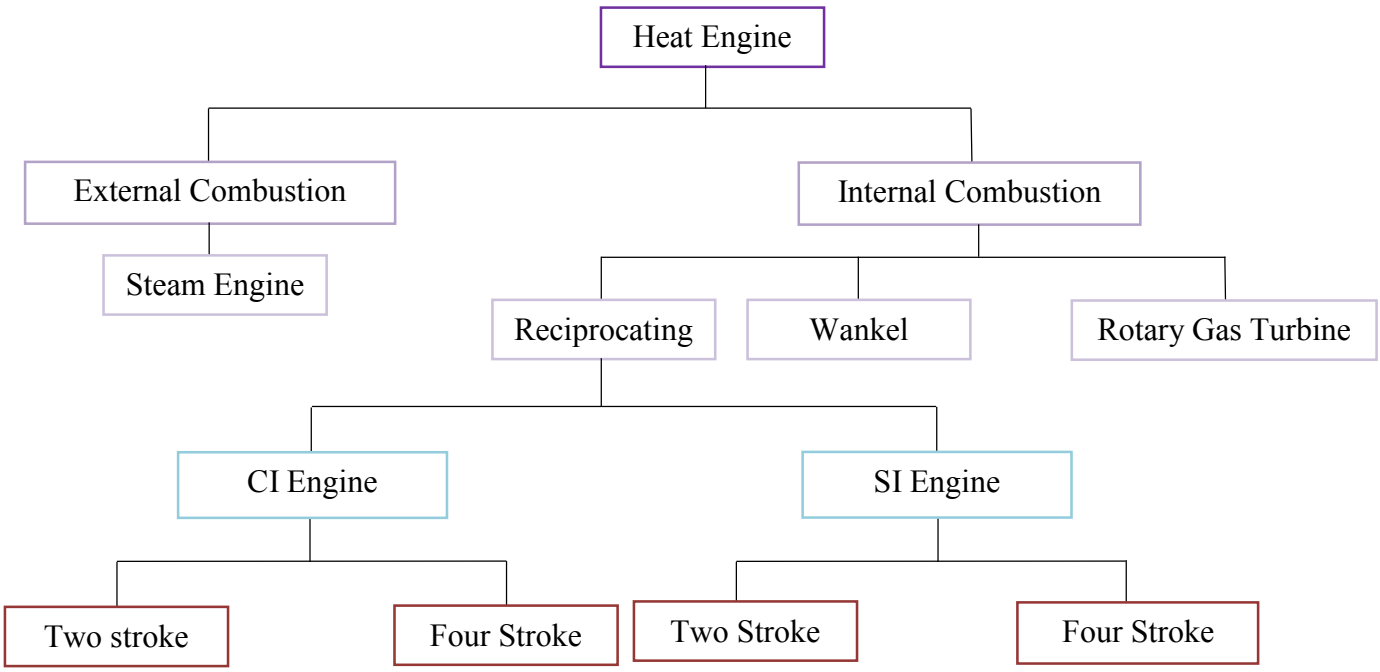

Figure 2.2: Types of heat engine (Hillagric,2008)