UNIVERSITI TEKNIKAL MALAYSIA MELAKA

STUDY THE ATTRIBUTES OF PRODUCTS AND PROCESSES FOR AUTOMOTIVE PRODUCT DEVELOPMENT: EXTERIOR AND INTERIOR PARTS

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

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Signature	:	…….
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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:

……

(Project Supervisor)

ABSTRAK

Industri automotif hari ini menghadapi cabaran hebat untuk memperlihatkan maklumat produk yang boleh memenuhi permintaan pelanggan yang abstrak. Kebanyakan syarikat memberi tumpuan untuk menentukan keperluan pelanggan. Walau bagaimanapun, kejayaan produk pada masa kini bukan sahaja bergantung kepada keperluan pelanggan tetapi juga bergantung kepada keberkesanan memperlihatkan maklumat produk bagi bahagian-bahagian automotif. Oleh itu, projek ini bertujuan untuk meningkatkan proses memperlihatkan maklumat produk dengan maklumat pengenalan sifat-sifat produk dan proses bagi bahagian-bahagian automotif. Selepas itu, perwakilan rasmi bahagian automotif berdasarkan sifat-sifat produk dan proses perwakilan. Bagi tujuan ini, satu templat iaitu Templat Sifat Formal Pemilihan (FAST) digunakan untuk mengenal pasti ciri-ciri produk. Sifat-sifat produk formal dinyatakan dari segi mereologikal dan struktur topologi dan penglibatannya dengan satu atau lebih proses. Untuk menilai pendekatan yang dicadangkan itu, perwakilan rasmi bahagian dibangunkan dengan cara ontologi. Sifat-sifat maklumat daripada menggabungkan FAST dengan Analisis Konsep Formal (FCA) digunakan untuk membina ontologi. Satu analisis kelompok hierarki telah dijalankan untuk menilai kehomogenan sifat-sifat yang dihasilkan. Hasil penilaian menunjukkan bahawa FAST boleh memberikan rasional reka bentuk ontologi.

ABSTRACT

Todays' automotive industry are facing a great challenge on eliciting the product information that can meet the abstract demand of customer. Most companies focus to define the customer requirements. However, the success of a product nowadays not only depends on customer requirements but also depends on the effectiveness of elicitation product information for automotive parts. Therefore, this project aims to improve the elicitation process by identifying the attributes information of products and processes for automotive parts. Subsequently, a formal representation of automotive parts based on attributes of products and processes representation. For this purpose, a template namely Formal Attribute Selection Template (FAST) is used to identify the product attributes. The product formal attributes are expressed in terms of its mereological and topological structure and its involvement with one or more processes. To evaluate the proposed approach, a formal representation of the parts are developed by means ontology. The attributes information from FAST combines with Formal Concept Analysis (FCA) are used to construct the ontology. A hierarchical cluster analysis was conducted in order to evaluate the homogeneity of resulting attributes. The results of evaluation show that FAST can provide the design rationale of the ontology.

DEDICATION

Specially dedicated to my beloved father Kamarudin Bin Sairi and my mother Siti Hamidah Binti Maulan.

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I would like to convey my gratefulness to Almighty Allah S.W.T for giving me a chance to complete this project. Secondly I would like to thank my supervisor, Dr. Suriati Binti Akmal for her constructive guidance encouragement and patient in completing this project. Without the great support from my supervisor, I can't be able to finish my PSM on time. Last but not least, I would like to express my sincere thanks to all my friends in UTeM who had given me support, ideas and information about the project. Besides, they are also willingly to share with me their final year projects which had then inspired me to construct a concise and comprehensive full report for my PSM.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

1.1 Background

Rapid changes of new technology, and Gen Y generation have created a volatile situation for automobile industry of the world. Gen Y is a generation that demands on a worldwide technology and sophisticated gadget likes smartphones. Thus, it forces the automotive industry producing a car that can connect to each other. Thus, the demand are becoming more abstract and it has a direct impact in on eliciting the right product information. In this situation, the advantage goes to the company that can offer a greater overall demand (Clark & Fujimoto, 1991). According to (Clark & Fujimoto, 1991), the new industrial competition that focuses so heavily on product development is driven largely by three forces that are the emergence of intense international competition: the creation of fragmented markets populated by demanding, sophisticated customers, and diverse transforming technological change. Therefore, for a company to stay competence in the automotive industry, an effective elicitation product information is the most important issue. This becomes a great challenge to engineer in designing a car in which the information and knowledge of automotive components are accumulated. Subsequently, the designer faces difficulties in sharing and scanning the information and knowledge. It is important for a designer to have the information and knowledge as early

as possible in the design process to avoid later modification at the last stage of the design process that are costly.

However, there is another issue in the early design stage where designers are always having problem in retrieving the product information and knowledge. This is due to the lack of formal knowledge representation in automotive industry. Also, designers are solving problem that are based on their past experience and difficult to record the problem and solution. Most of the engineers did not record or documented all the necessary information regarding the produced product. The new generations of engineers have to find themselves all the necessary information from the beginning.

With the aid of knowledge representation using ontology approach, all the necessary information needed can be share and reuse at anytime they need. Ontology is the computer representation process which captures the semantic of thing represented in its domain (Akmal & Batres, 2013). PRONTO, MASON and ADACOR are several of ontology that has been develops in manufacturing domain.

In this research, we propose a systematic method to develop the ontology. The proposed method is based on the process participation in the product. There are various approaches commonly used to develop ontology. One of the methods is using Formal Concept Analysis (FCA). FCA is an analysis technique for knowledge processing that is based on applied lattice and order theory. It employs a set of objects and the formal attributes to identify hidden relationships. None of the proposed method is emphasizing on the important of attributes characterization.

This project focuses on the identification of attribute of product that is characterized by the process that participates in the product. The characterization is based on the template called Formal Attribute Specification Template (FAST). The product participated in this

project is the automotive body parts that consist of 28 parts. Attributes of each part will be analyzed according to the process participation involved on each part.

1.2 Problem Statement

By the intensifying growth of knowledge and information of process related to automobile parts, there is plenty of information that are not standardize especially at the product development stage. The information obtained usually not being properly documented and recorded by the previous engineer and being kept in mind. Thus, there is no formal representation of process participation considering the automobile body that can ensure the new product can be produce in timely manner. Henceforth, it has been the barrier for the most engineers, especially for the freshly graduated engineer to make reference and decision in the early stage of product development of automobile body.

1.3 Objectives

The main objective of this project is to improve the effectiveness of elicitation product information of the automotive parts. To achieve the main objective, it consist the following sub-objectives:

i. To list the attributes of parts based on products and processes representation.
ii. To develop a formal representation of automotive parts based on attributes of products and processes representation.

1.4 Research Scopes

This project is focusing on the attribute identification of automotive parts. The FAST is used to identify the attributes by (1) the object transform by the process, (2) object produced by the process, (3) performers that used by the process, (4) Location that always accommodate the process and (5) Process composition. All attributes that are identified are tabulated in a context table. Based on the context table, taxonomy is generated. This project uses ConExp as a tool to generate the taxonomy. In evaluating the taxonomy that consist attributes information, we generate a class hierarchy using an ontology editor called Protégé. The developed class hierarchy consists of attribute information for 28 parts of automotive exterior and interior body.

In evaluating the accuracy of the attribute information, a homogeneous analysis is conducted on the developed class hierarchy. For this purpose a semantic similarity is used to calculate the similarity of two classes. In this view, the more common attributes they share, the more similar they are.

CHAPTER 2
LITERATURE REVIEW

2.1 Formal Attribute Selection Template (FAST)

In the selection of attributes, there are several criteria that are used. Formal Attribute Selection Template (FAST) is a template developed specifically for the attribute identification of a specific class given (Akmal, 2013). This guideline is used to characterize the classes of products and processes and identify the relationship between them. FAST has differentiated the formal attributes in products and in processes. In products, FAST identifies the following types of formal attributes:

- The classes of objects that construct the product (the product parts)
- The classes of places where the product is supposed to be
- The classes of process the product participates

In process, FAST identifies the following types of formal attributes:

- The classes of objects that are always transformed by the process (the input process)
- The classes of objects that are always produced by the process (the process output)
- The classes of performers that are always used by the process

- The classes of locations that always accommodate the process
- The classes of process composition (the parts of the process)

Figure 2.3 illustrates the selection steps involve in selecting the formal attributes of a given class of product, whereas Figure 2.4 shows the selection steps in selecting formal attributes for a given class of process (Akmal, 2013). The formal attributes selected will be used in the context table. All five criteria must be considered during selecting the formal attributes of products or processes. The formal attributes in the FCA context table are defined as the limitations about the meaning of the specific class of products and processes. The formal attributes in the context table always being able to modify if other formal attributes about the specific class of products or processes is determined.

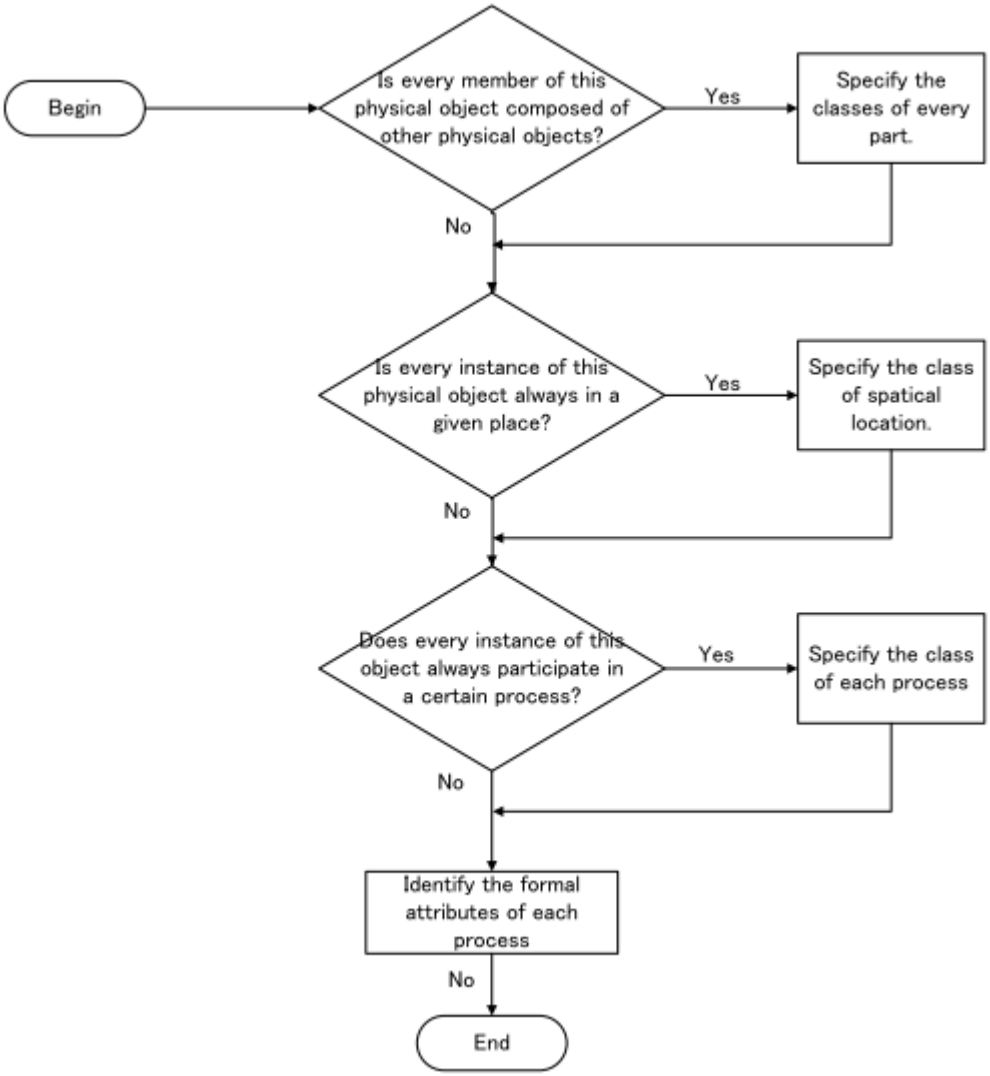

Figure 2.1: Flow chart of formal attribute selection of a given class product (Akmal, 2013)

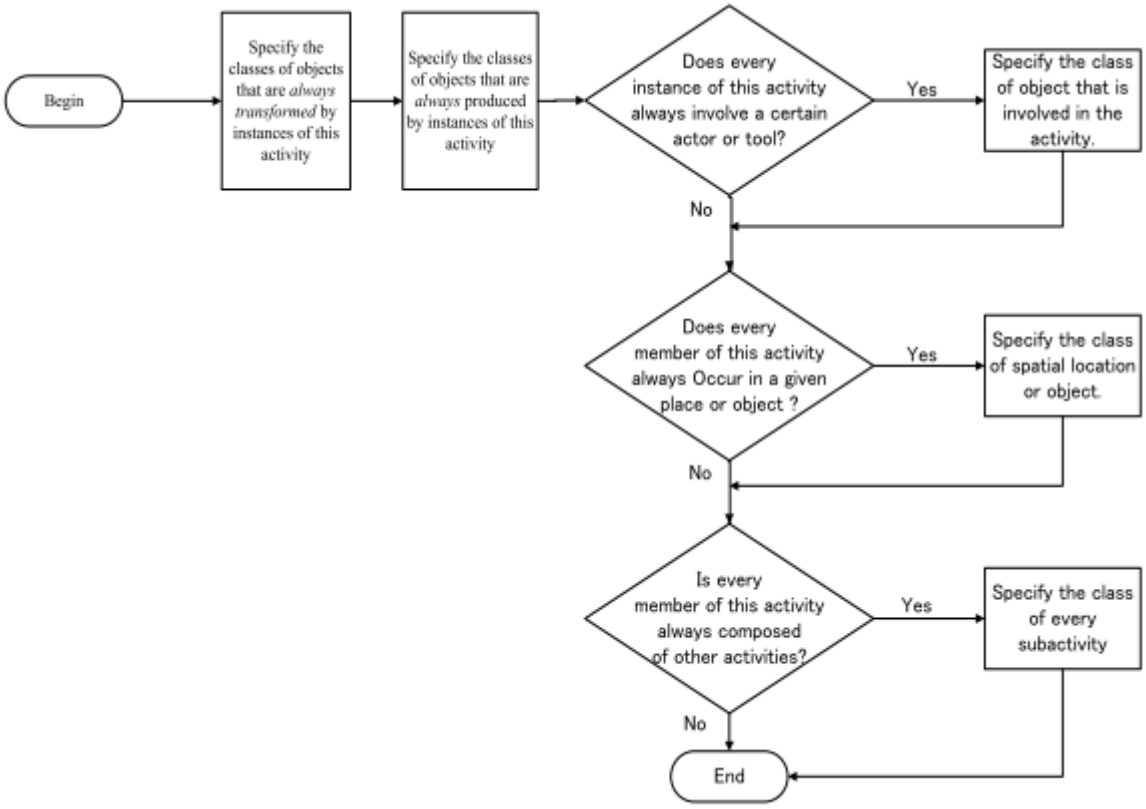

Figure 2.2: Flow chart of formal attributes identification of a given candidate class (Akmal, 2013)

2.2 Formal Concept Analysis (FCA)

(Akmal & Batres, 2013) explained that Formal Concept Analysis (FCA) is an analysis method to process knowledge or information based on applied lattice and order theory. FCA applies objects as formal attributes for the identification of the relation between the attributes. This analysis is used for the maintenance of ontology as long as the ontology uses potential classes during the ontology development. The definition of a set of formal objects, formal attributes and binary relations are important in the first step of FCA. The three sets are then will be represent in the context table. In a context table, the formal attributes will be located in the first row of the table whereas the formal objects such as class1, class2 and class3 will be located in the row of the first column. Figure 2.5

illustrates the example of a context table. The checkmark is located in the box that has the relation between the specified formal attributes and formal classes.

A formal concept is defined as the pair $< O_i, A_i >$ such that:

1. $O_i \subseteq O, A_i \subseteq A,$
2. Every object in O_i has every attribute in A_i. Conversely, A_i is the set of attributes shared by all the objects in O_i ;
3. For every object $o \in O$ that is not in O_i, there is an attribute in A_i that o does not have;
4. For every attribute in A that is not in A_i, there is an object in O_i that does not have that attribute.

Formal concept can be partially ordered into a lattice, such that a concept subsumes another concept. Figure 2.6 shows the lattice obtained with the data of Figure 2.5.

Formal objects	Formal attributes						
	attr1	attr2	attr3	attr4	attr5	attr6	attr7
class1	x	x					
class2		x					
class3		x	x				x
class4	x	x		x	x		
class5		x		x			
class6		x		x			
class7		x		x			
class8		x		x	x	x	
class9		x		x	x	x	

Figure 2.3: A context table (Akmal & Batres, 2013).

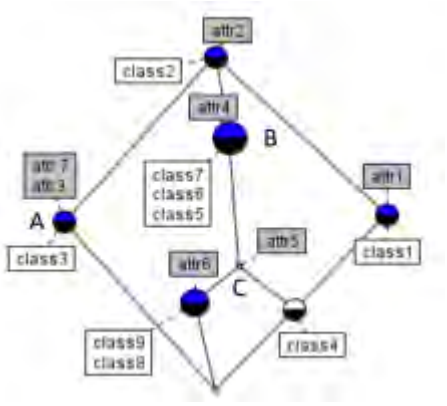

Figure 2.4: A concept lattice (Akmal & Batres, 2013).

2.3 Ontology

Ontology is a computer representation that captures the semantics of things represented in a specific domain (Akmal & Batres, 2013). Generally, ontology consists of classes, relations and axioms (Akmal & Batres, 2013). A class shows a set of things that share the same attributes. For example, all the members of the class "cutting" use cutting operation to remove material. Relations express the relationship between two or more things. For example, A is "less than" or "connected to" or "part of" B. Above all, the subclass relation is determined for managing classes in the form of the class hierarchy. (Batres et al., 2013) explained that ontology can be developed using two approaches which are top-down or bottom-up approach. Top-down approach begins with a high level concept that is then assumed to be common to many application areas. This approach is easier to maintain which aid in the ontology applications. On the other hands, the bottom-up approach begins with the most specific concepts in a domain application. This approach is slightly difficult to modify and integrate. It is also explained in the paper that the construction of ontology is by defining the classes of things, the things' taxonomy, the possible relations between things, and axioms for those relations.

2.3.1 Ontology Construction

There are many methods in constructing the ontology. (Akmal et al., 2014) explained that the general phases in constructing ontology are: identification of purpose and scope, acquisition of information, conceptualization, integration, encoding, documentation and evaluation. Figure 2.5 illustrates the more detail methodology for ontology construction using the FCA approach for attribute selection.

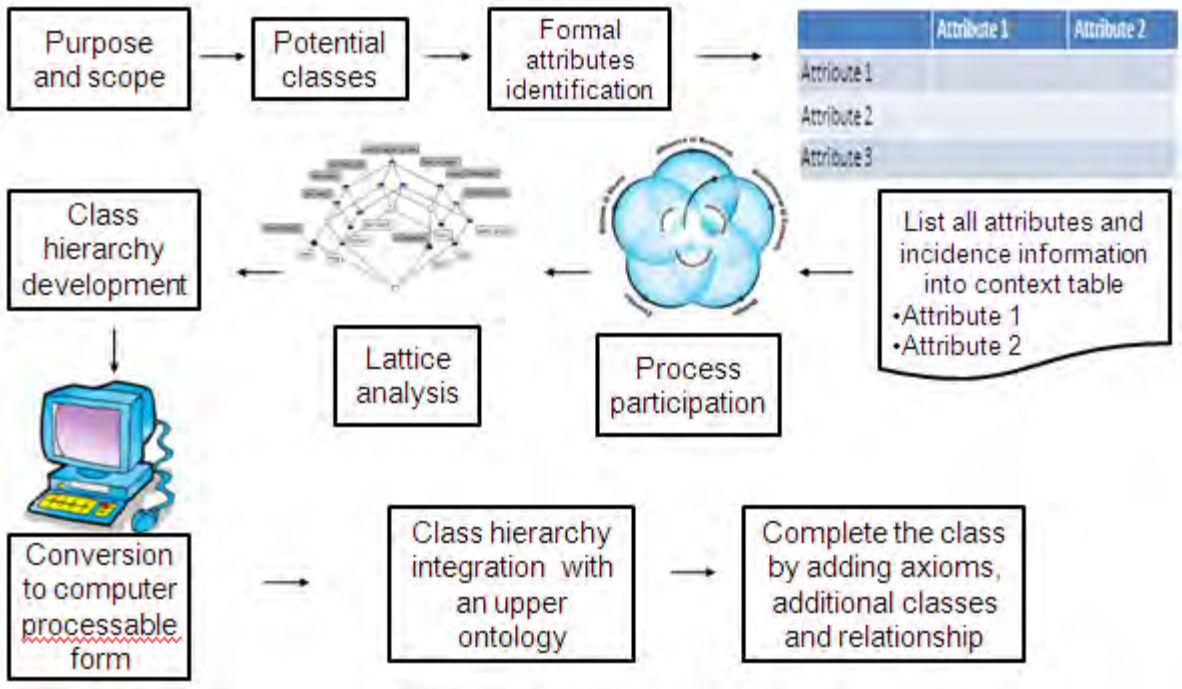

Figure 2.5: Flow diagram of ontology construction (Akmal & Batres, 2013)

2.3.2 Application of ontology in automotive industry

Ontology has been widely used in the automotive industry (Zhang et al., 2009). Ontology is useful for supporting the knowledge or information development (Beydoun et al., 2014). There are many ontology that have been developed for the information development, such as Project-handling Module based Decision-making Ontology Model