



Faculty of Engineering Technology

**Incorporating Flywheel Hybrid Module in Motorcycle : A Conceptual
Design Approach**

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This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Automotive Technology) (Hons.)

Faculty of Engineering Technology

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DECLARATION

I declare that this thesis entitled **incorporating flywheel hybrid module in motorcycle : a conceptual design approach** is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name :

Date :
.....

APPROVAL

I hereby declare that I have read this report and in my opinion this report is sufficient in terms of scope and quality as a partial fulfillment of Bachelor of Mechanical Engineering Technology (Automotive Technology) (Hons.).

Signature :

SupervisorName :

Date :

ABSTRACT

Flywheel Hybrid Module conceptual project emphasizes on the producing the initial concept of the system. Determining the customer requirement on a hybrid technology. Afterwards, benchmarking between market products in producing the engineering characteristic. All the data obtained then used to construct a house of quality that will determined the final product design specifications. From the specifications, a functional analysis method will be used that will go through morphological step, concept generation, concept screening, decision tree, concept scoring, and finally concept selection.

ABSTRAK

Projek konseptual Flywheel Hybrid Module menekankan kepada pembentukan konsep awal sistem. Permulaannya ialah dengan menentukan permintaan pelanggan. Kemudian, melakukan penanda aras di antara produk yang telah berada di pasaran untuk menghasilkan spesifikasi teknikal. Semua data yang diperolehi kemudian digunakan untuk menghasilkan hubungkait kualiti yang akan menentukan spesifikasi produk. Dari spesifikasi produk yang terhasil, kaedah analisis fungsi akan digunakan yang akan melalui proses penggabungan, penghasilan konsep, penapisan konsep, pemilihan bercabang, pemarkahan konsep dan akhir sekali pemilihan konsep.

DEDICATION

I would like to thanks to everyone who involved in finishing my final year project.

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CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays there are many cars produced at the road and cause increase of environmental pollution . Therefore, in order to reduce the humongous amount of carbon flying on our atmosphere serious action should be make. an inefficient of internal combustion engine was the major contribution to number of carbon increase realease to atmospheres. Therefore, hybridization process needs to be established in decreasing the usage of internat combustion engine. The advantage is that it can reduce the carbon impact on environment ad it also benefit the user in term of saving.

The basic concept of this flywheel hybrid powertrain is orignally came from the basic kid's toys car. The toy car use a small radius metal disk known as flywheel to store the generated kinetic energy coming from the wheel during the pushing of the car backward. When the car is released after the backward pushing action, the kinetic energy that generated and stored inside the flywheel is then transfer back to the wheel and thrust the toy car forward. The concept applied here are the regenrative braking concept and propulsion of power concept. (Manaf et al. 2013)

SYSTEM LAYOUT

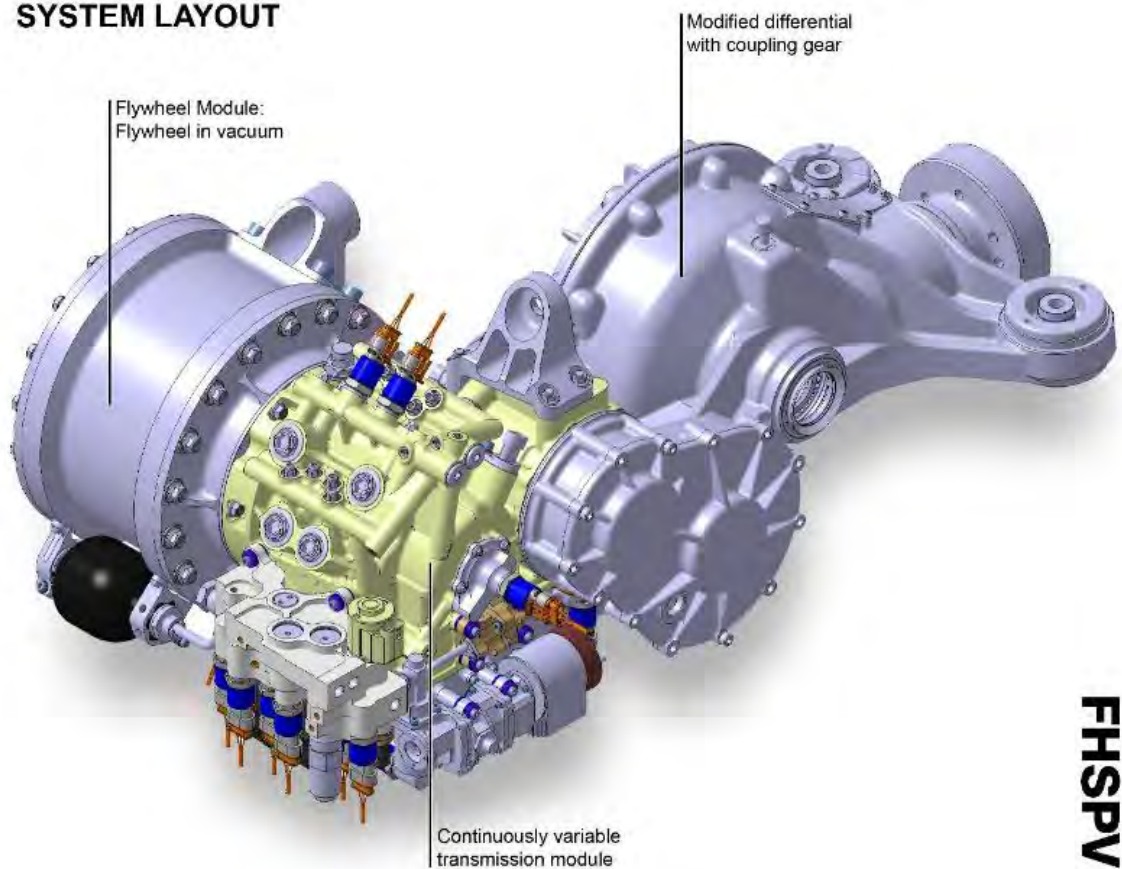


Figure 1-1: Flywheel hybrid system of Jaguar.(Cibulka 2009)

The Jaguar has come up with the latest technology development in automotive industry which one of it the flywheel hybrid system as shown in figure 1-1 above which also consist of some features such as start and stop function. The consortium of British company develop this system and it also include names such as Prodrive and Xtrac, which can produce recovered energy that using intergrated hybrid module that can go up to 80hp. Additionally, It can saves the fuel consumption by almost 10 percent efficiency increament in the industry-standard one. Yet the currently the best hybrid system is call a new cycle ARTEMIS that could increase the fuel efficiency at 20 percent.

For the past 10 years, the development and usage of flywheel in cars have got increase. Due to its functionality in fuel efficiency, consistent reduction of CO2 emission. Furthermore , with hybridization it affect the local environmental concern such as noises and esmission. see **Figure 1-2** and Error! Reference source not found..



Figure 1-2: Formula 1 Flywheel Hybrid System 2009 season.(Cibulka 2009)

The Jaguar flywheel system is made of composite material and with the combination driving wheel which made by CVT gearbox that only weighs around 60 kg and capable in storing 115 Wh at speed of 55000 rpm which the maximum power delivery capability of 60 kW.see **Figure 1-3**



Figure 1-3:Jaguar hybrid car flywheel(Cibulka 2009)

For KERS system, there are 2 type of basic type that is mechanical and electrical and what differentiate between them is the energy convert and stored in the vehicle system.

There are five phases that needed to be incorporate to execute and finish this project. The first is the Conceptual Design phase or P1. In the conceptual design , it consist of drawings and products concept. It provide details of the proposed systems in terms of ideas, several concepts, and behaviour.

Next is Embodiment design phase or P2. The embodiment design connecting the conceptual phase and the details design as a bridge. Embodiment consist of definitive layout, introductry form design (component materials and shapes), production informations, industrial design, process selection and materials.

Next, Simulation and Analysis or P3. Simulation define as the virtual imitation of real world operation process. It requires a developed model that have key characteristic. Analysis define as details study of something to learn about its parts , how is they related to the problem, and what the can do.

Next is Performance Optimization phase or P4. It define as methodology of producing something such as design system or decision as fully perfect or effective and it is also known as mathematical approach procedures.

Lastly is Prototyping and Testing phase or P5. Defined as a prototype that built for demonstraion uses or as part of the development process. A basic system is built, tested and reimproved if necessary until an acceptable prototype is produced to be developed.

In this paper, the Conceptual Design phase or P1 was selected by me. This report will focus more on how to apply the conceptual design which is the most important key of this project to proceed to next phase .

1.2 Problem Statement

1. Automakers, governments and customers are now more attracted towards the issues of critical law on emission, fuel economy, green gas emission that lead to global warming and restriction on energy resources, hybrid and fuel cell vehicle. **A reliable electric powertrain and low-cost system novel concept is being rapidly developed** (Chan 2007). Customer have their own needs in designing a product. Customers needs, expectation and changes is the key of a company success.(Soota, Singh, and Mishra 2008). To gain reduction in gap of internal quality and externam customer satisfaction, any firms must actively involve in business industry to compete and improve their company service quality (Lin 2007). Engineer also have their own specifications that has to be followed to create the same product .Hence, there is a problem in relating customer need with engineering specifications in creative concept method. Therefore to solve this problem there is one method that known as Quality Function Deployment (QFD). In

QFD the Voice of Customer (VOC) is related to the Engineering Characteristic (EC) through House of Quality (HOQ) method to produce Product Design Specifications (PDS).

2. To induces consumer usage of hybrid vehicle, the governments proposed various of incentives. Sales tax waivers, income tax is connected with more than ten times increament with conditional value. **Increasing in petrol prices** linearly connected with increament of hybrid vehiclc sales. (Gallagher and Muehlegger 2011). When the importance of the relation between VOC and EC has be determined where we know the PDS. The physical and function decomposition of the product that need to be made. Problem arise when breaking down the physical and functional of the product and to come up with an improvement of the new product. Therefore, there is a method to solve this problem where it involve multi-dimensonal matrix consist of ideas represent in a sketch form known as Concept Generation. In concept generation there is functional analysis , morphological chart where few new concept of the product can be produced systematically.
3. The cheap oil era is rapidly reaching its end and could happen around 2010. For a **healthier environment, improvement of traffic**, hybrid vehicle are an important factor due to their beneficial effect in urban area.(Maggetto and Mierlo 2000). Multiple choice and criteria decision problem is always a regular problem in engineering design (Frey and Clausning 2007). When deciding the most suitable concept at the end of the concept generation, there is a conflict when there is a same importance percentage rank between concepts and the deciding process need to be done again without knowing the exact possibilities. Therefore, to solve this problem , the functional analysis method is used.

This method compares to determine the best concept among all the concept proposed.(Dieter & Schmidt , 2008).

1.3 Aim and Objectives

The aim of this study is to incorporating flywheel hybrid module in motorcycle by conceptual design approach . In order to achieve the aim, the following are the three objectives that needed to be accomplished:

1. To develop the technical specifications of FHM in automobile using QFD method.
2. To generate the physical and functional decomposition and develop morphological chart
3. To generate and evaluate the concepts using functional analysis method.

1.4 Scope

The scope of this Flywheel Hybrid Module study is divided into three phases as discuss below.

1.4.1 Scopes of phase 1: Quality Function Deployment (QFD).

The limit of the QFD method is only helping in changing the way people plan and choosing new products , design the requirements , determine process , manufacturing process control and redocumenting existing product details of the FHM.

1.4.2 Scopes of phase 2: Morphological analysis

The limit of the Morphological chart analysis is it catalog and subsequently evaluate the possible combinations of embodiments to find the combination that will result in the best design concept.

1.4.3 Scopes for phase 3: Functional analysis method

Functional analysis define as the flow of system do's and dont's. The execution of every function have to be done to meet the operational requirements needs which then identified to define the in terms of limiting requirements.

1.5 Structure of the Project

Chapter 1 states the problem and background of the study. This chapter also discussed the objective, hypothesis and scope of the project. So that the reader can get an initial idea about what the project is all about.

Chapter 2 explains in detail about literature review of the study. It consists of the general problem that this study tries to overcome. It explains about the implimentation of the Flywheel Hybrid Module into a motorcycle. The method of diagnosis and preventive are also discussed here.

Chapter 3 explains the methodology of this study. There are three phases in this study. Phase 1 is the To develop the technical specifications of FHM in automobile using HOQ / QFD method . Phase 2 focus To generate the shape and function of the FHM using morphological and functional analysis / functional decomposition and synthesis method . Final phase suggests To evaluate the concepts of the FHM using Pugh analysis method..

Chapter 4 is analysis and discussion chapter. The results from the investigation phase 1 and experiments in phase 2 and phase 3 are analyzed here. In experiment result, the final result will be analyze until it satisfy the objective of project.

Chapter 5 is conclusion chapter. It conclude the findings from this study. Generally, there are energy store in hybrid flywheel. This is proven through the past review on research and past paper. The experiment result also being shown to get a better result other the past experiment. Finally future preventive method is suggested to make some improvement for the hybrid flywheel focus on optimization in the future.