INCORPORATING DESIGN FOR MANUFACTURE AND ASSEMBLY METHODOLOGIES INTO THE DESIGN OF A MODIFIED SPARK PLUG

NIK MOHD FARID BIN CHE ZAINAL ABIDIN

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To my beloved wife Silah Hayati Kamsani, my father Hj Zainal Abidin Harun,
my mother Nik Maimunah Nik Daud and my siblings
I love you all.

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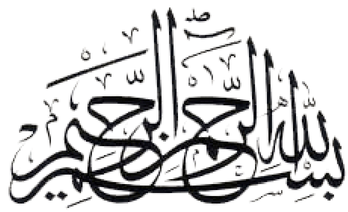

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May Allah S.W.T bless all of us. Amin.

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ABSTRACT

Air Pressure Plug is a product that can be used to inflate the inflatable items using the air from the internal combustion engine, which is channeled out using this device. This product is a good design to be commercialized. However, before releasing to the market, the product has to be cheap and good quality. Therefore, to achieve this goal, design for manufacture and assembly methodologies are used to evaluate the design of the product. Specifically, DFMA, which is Boothroyd-Dewhurst based software, and TeamSET, which is based on Lucas-Hull, are used to evaluate the product. The results for both analyses are compared to look for any variation in term of parts to be eliminated and combined.

ABSTRAK

Air Pressure Plug adalah satu produk yang boleh digunakan untuk mengisi angin pada barang-barang seperti tayar, pelampung, atau tilam angin dengan menggunakan angin dari kebuk pembakaran dalamanenjin. Angin disalur keluar dari dalam enjin dengan mengunakan produk tersebut. Produk tersebut adalah sangat berpotensi untuk dipasarkan. Walau bagaimanapun, produk itu haruslah berkualiti dan murah sebelum ianya dijual di pasaran. Oleh yang demikian, untuk mencapai matlamat tersebut, kaedah "*Design for Manufacture and Assembly*" (DFMA) digunakan untuk menilai reka bentuk produk. Dua perisian yang berbeza digunakan untuk menilai reka bentuk produk iaitu perisian DFMA yang berdasarkan teknik Boothroyd-Dewhurst dan TeamSET yang berdasarkan teknik Lucas-Hull. Hasil keputusan penilaian dengan menggunakan kedua-dua perisian itu dibandingkan di antara satu sama lain untuk mengenalpasti sebarang perbezaan berdasarkan komponen yang akan dibuang dan dicantum dengan komponen lain bagi mengurangkan jumlah komponen.

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CHAPTER 1

INTRODUCTION

1.1 Introduction to the Problem

Air Pressure Plug is a product that inflates the inflatable items. It is a device that uses the air generated from the internal combustion engine. Air as a by-product of combustion can be channeled out from the engine through this product. Air Pressure Plug has a very good potential to be commercialized based on the number of inquiries received when the product was exhibited locally and internationally. It is targeted to be commercialized by end of 2007. Two major factors that have to be emphasized before the product can be released to the market are the price and quality of the product. These factors are one of the few factors that will determine the product successfulness in the market place. Therefore, it is crucial to study and analyze the product to achieve optimum cost without scarifying the quality of the product. In fact, the product has to be a best quality product. One of the tools that can be used to minimize the product cost and to increase the product quality is through applying Design for Manufacturing and Assembly (DFMA) methodologies to the product design. Design for Manufacturing and Assembly (DFMA) is an approach that eases the manufacturing and assembly of the product. Specifically, this project shall use Boothroyd-Dewhurst and TeamSET-based Lucas Hull DfMA softwares to evaluate the product design. Parts of the product that have potentials to be improved will be identified by the software. After the improved design has been made, product shall again be evaluated before the product is ready for fabrication.

1.2 Objective of Project

The objective of the project is to design and evaluate the original and improved Air Pressure Plug using Boothroyd-Dewhurst and TeamSET-based Lucas Hull DfMA softwares.

1.3 Scope of Project

The scopes of the project are:

1. The use of Air Pressure Plug as a case study product.
2. The use of Boothroyd-Dewhurst and TeamSET-based Lucas Hull DfMA softwares for product evaluations.
3. Product improvement for product structure simplification.
4. Comparison on product assemblability design efficiencies.

1.4 Project Methodology

The project is conducted in two consecutive semesters which are summarized in Figure 1.1.

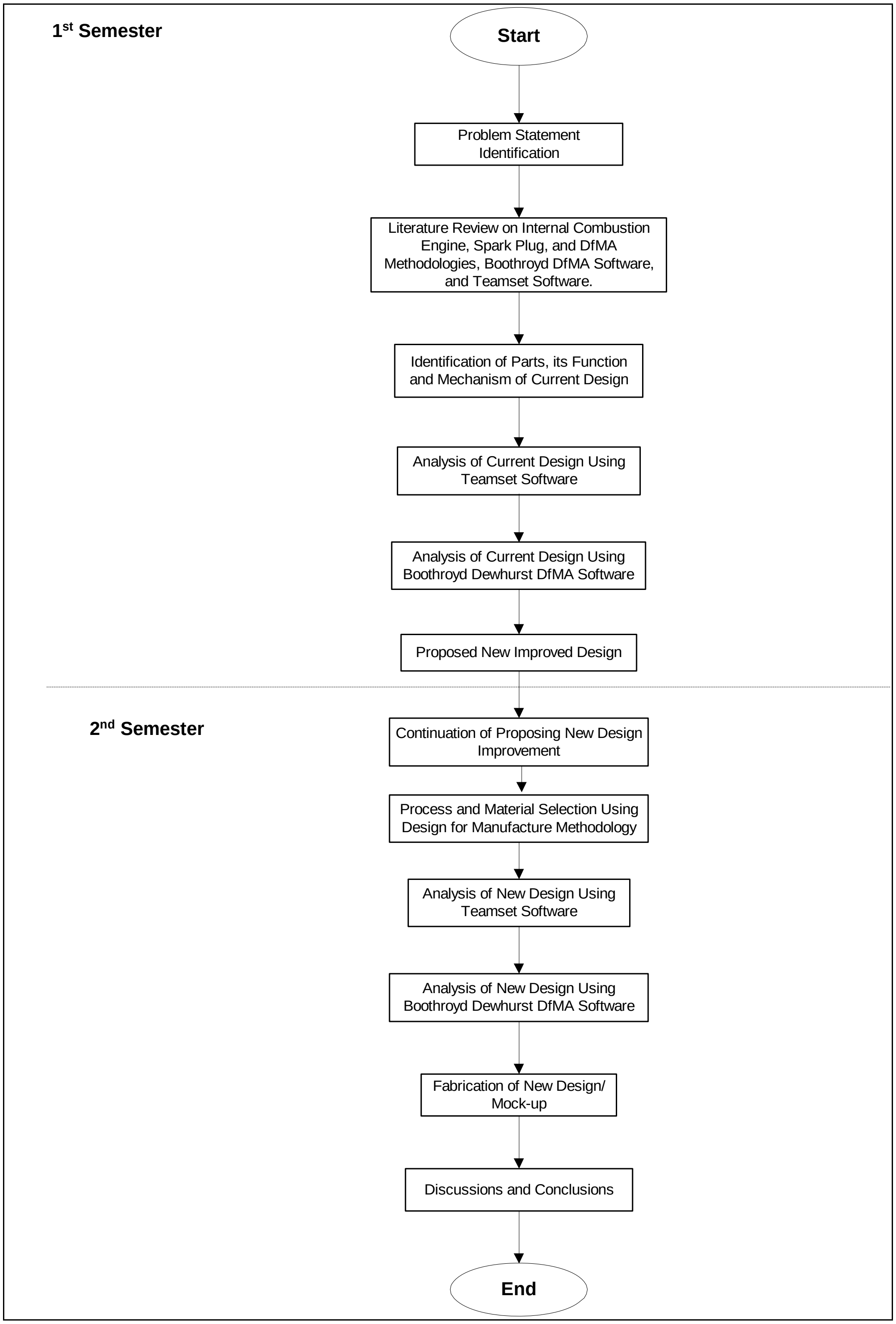

Figure 1.1: Project methodology.

This project shall be completed in two semesters. The project activities for every semester are demonstrated in Gantt chart in Appendix A1 and Appendix A2.

This project begins as soon as the problem statement has been identified in the first semester. It is important to identify the problem because it shall reflect the direction of this project. Next stage is literature review of the related areas that are internal combustion engine, spark plug, Design for Manufacturing and Assembly (DFMA) methodologies, DFMA software (based on Boothroyd-Dewhurts method) and TeamSET software (based on Lucas-Hull method). At this stage it is important to learn and explore how to use those softwares because it is used to evaluate the current production the later stage. Then, study on the current design of the product is conducted by identifying various components of the product, its various functions and mechanisms. The following stage is to do analysis using both softwares which are DFMA and TeamSET. Based on the evaluation of the product, a new an improved design of the Air Pressure Plug is proposed.

In second semester, continuation of the earlier proposed new improved design of an Air Pressure Plug takes place in which various components function and mechanisms shall be identified. Using Design for Manufacture methodologies process and material selection are made for each components of the product. Then new improved design of product is evaluated and analyzed using DFMA and TeamSET softwares. After satisfied with the improvements done to the design, the new design shall be fabricated in which a mock-up of the product will be produced. The mock-up of the product shall be tested in term of its assemblability in which the product shall be easier to assemble compared with the previous design. Finally, this project shall discuss the results and findings of this project and make conclusion for the whole project from first semester to the second semester.

1.5 Significant of Findings

The main purpose of the Design for Manufacturing and Assembly (DfMA) methodologies is to achieve product structure simplification. By applying DfMA, the Air Pressure Plug product structure can be simplified through elimination of unnecessary parts or components. These parts elimination translates into reduction of assembly and total product cost. Also, it shall improve the product quality through process and material selection, and product assemblability. Once all of these are achieved the product can be commercialized and released to the market. In fact, this approach shall increase the product competitiveness in the market place.

1.6 Report Structure

Chapter 1 covers the introduction of this project by looking at problem identification, objective and scope of the project. It also briefly explains the project methodology from the beginning of the project 1 in semester 1 until the completion of project 2 in semester 2. Then it touches on the significant of the findings of this project, report structure for project 1 and summary of the project 1.

Chapter 2, which is the literature review, covers internal combustion engine, design for manufacture and assembly methodologies, TeamSET and DFMA software. In the area of internal combustion engine, two types of internal combustion engines, which is two-strokes and four strokes engine, are being discussed in term of basic principles. Also covered in this area is the spark plug in which basic principle and identification of various components with brief explanation on its function and manufacturing processes. Then, TeamSET and DFMA software are covered by looking at how that software can be used to help the execution of this project.

Chapter 3 is a case study of the product. The product selected for case study is an Air Pressure Plug. Basic design concept of the product is touched in the early chapters. Also, method of using the product is briefly explained showing photos of various steps. In this chapter, the product is broken down to each part which illustrated in exploded drawing of the product. In addition, identification of each part function and mechanism is covered. Report on the analysis done using TeamSET and DFMA softwares, is provided. Based on the analysis of the results, a new improved design is proposed.

Chapter 4 covers the evaluation of the current design of Air Pressure Plug using both TeamSET and Boothroyd-Dewhurst DFMA softwares. The software is used to select the appropriate processes and materials for the parts, which is planned to be manufactured. In fact, it will give the estimate cost for the parts to be manufactured. Furthermore, both softwares are used to evaluate the ease of assembly for the product in which both used different Design for Assembly methodology. TeamSET is based on Lucas-Hull DFA methodology, whereas DFMA software is based on Boothroyd-Dewhurst DFA methodology.

Chapter 5 is where the proposed improvement of the Air Pressure Plug is made based on the result of the evaluation which is done in the previous chapter. The improved design is being conceptualized taking into consideration the parts that are recommended to be eliminated. A few conceptual designs are generated and the best conceptual is selected as the improved design of the product.

After coming up with the improved design, the Chapter 6 evaluates the design using TeamSET and Boothroyd-Dewhurst DFMA softwares. Again, similar process of material and process selection, and design of assembly analysis using the two softwares take place.

Chapter 7 is the discussion on evaluation comparison between the old design and the improved design of product for each of the methodology used. Furthermore, evaluations made based on TeamSET and Boothroyd-Dewhurst DFMA softwares are compared to each other.

The final chapter, which is Chapter 8, is the conclusion and future work recommendations. This is where the conclusion on the project is made based on the activities which have been done through out the two semesters. Also included in this chapter is the recommendations of future works related to this area that have not been explored.

1.7 Summary

The project is to improve the existing design of an Air Pressure Plug. Design for manufacture and assembly is applied to the product with the aim of product structure simplification. Specifically, TeamSET and DFMA softwares are used to evaluate the product design in which the resulted into faster and easier product evaluation compared to the manual method. Based on the identification of parts that should be considered for elimination by TeamSET and DFMA, an improved Air Pressure Plug design is proposed. This new improved design shall undergo similar product design evaluation using TeamSET and DFMA in the second semester. Mock-up fabrication of the new design shall also be done in second semester.

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