Redesign of a Manual Wheelchair Through Concurrent Engineering Tools

Thesis submitted in accordance with the requirements of the Universiti Teknikal Malaysia Melaka for the Bachelor Degree of Manufacturing Engineering in Manufacturing Design

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This thesis submitted to the senate of KUTKM and has been accepted as fulfillment of the requirement for the Degree of Bachelor of Manufacturing Engineering (Design). The members of the supervisory committee are as follows:

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ABSTRACT

This report describes about the implementation of redesign the manual wheelchair by using the application of concurrent engineering. The scope based on the existing wheelchair design and the appropriate application of Concurrent Engineering (CE) tools. The method used for gaining the data was from the survey done by distributing of questionnaires to several numbers of people and the wheelchair user. From the data achieved, it can be classified into several categories to be studied. Data will be analyzed by using the Quality Function Deployment (QFD) method to verify the highest rank from the people and customer requirements. The new proposed design of wheelchair was drawn using SolidWorks software based on the QFD result achieved. In the same time, both design and redesign of manual wheelchair were analyzed by using the Design for Assembly (DFA) tools which is TeamSET software, to compare the design efficiency to achieve the objectives of the project. Result shown that the design efficiency for redesign manual wheelchair obtained better percentage rather than the existing design. From the study, even the redesign possesses a greater number of part compared to the existing design, it still has the advantages based on the convenience functions and the percentage of design efficiency. Eventually, the improvement of wheelchair design finally will be able to meet user requirements and satisfactions.
**ABSTRAK**

Kertas kerja ini menguraikan tentang perlaksanaan dalam mereka bentuk semula kerusi roda manual dengan menggunakan aplikasi Kejuruteraan Serentak. Skop projek adalah memfokus kepada rekabentuk asal kerusi roda dan disertakan dengan aplikasi Kejuruteraan Serentak. Kaedah yang digunakan untuk mendapatkan data adalah daripada tinjauan dengan mengagihkan borang soal selidik terhadap segolongan individu dan juga kepada pengguna kerusi roda sendiri. Hasil data yang telah diperolehi akan dikelaskan kepada beberapa kategori sebelum analisa dilakukan. Kemudian, kesemua data tersebut akan dianalisa dengan menggunakan kaedah QFD (Quality Function Deployment) untuk mengelaskan kepentingan, keperluan dan kehendak pengguna. Daripada keputusan yang telah diperolehi, rekabentuk kerusi roda yang baru akan dilukis dengan menggunakan perisian SolidWorks. Dalam masa yang sama, kedua-dua rekabentuk kerusi roda sebelum dan selepas direkabentuk tersebut akan dianalisa dengan menggunakan perisian TeamSET, salah satu perkakasan daripada DFA (Design for Assembly) untuk membandingkan keputusan yang diperolehi sebagai pencapaian objektif projek. Hasil daripada kajian mendapat bahawa kecekapan rekabentuk untuk rekabentuk semula menghasilkan peratusan yang lebih tinggi berbanding dengan rekabentuk asal. Walaupun rekabentuk semula mempunyai nilai bahagian yang lebih banyak berbanding dengan rekabentuk asal, namun begitu rekabentuk semula tetap mempunyai kelebihan dari segi kemudahan fungsi dan peratusan kecekapan rekabentuk. Akhirnya, perbaikan rekabentuk kerusi roda akan mampu untuk memenuhi kehendak dan kepuasan khususnya para pengguna.

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ABSTRAK

Kertas kerja ini menghuraikan tentang perlaksanaan dalam mereka bentuk semula kerusi roda manual dengan menggunakan aplikasi Kejuruteraan Serentak. Skop projek adalah memfokus kepada rekabentuk asal kerusi roda dan disertakan dengan aplikasi Kejuruteraan Serentak. Kaedah yang digunakan untuk mendapatkan data adalah daripada tinjauan dengan mengagihkan borang soal selidik terhadap segolongan individu dan juga kepada pengguna kerusi roda sendiri. Hasil data yang telah diperolehi akan dikelaskan kepada beberapa kategori sebelum analisa dilakukan. Kemudian, kesemua data tersebut akan dianalisa dengan menggunakan kaedah QFD (Quality Function Deployment) untuk mengelaskan kepentingan, keperluan dan kehendak pengguna. Daripada keputusan yg telah diperolehi, rekabentuk kerusi roda yang baru akan dilukis dengan menggunakan perisian SolidWorks. Dalam pada masa yang sama, kedua-dua rekabentuk kerusi roda sebelum dan selepas direkabentuk tersebut akan dianalisa dengan menggunakan perisian TeamSET, salah satu perkakasan daripada DFA (Design for Assembly) untuk membandingkan keputusan yang diperolehi sebagai pencapaian objektif projek. Hasil daripada kajian mendapati bahawa kecepatan rekabentuk untuk rekabentuk semula menghasilkan peratusan yang lebih tinggi berbanding dengan rekabentuk asal. Walaupun rekabentuk semula mempunyai nilai bahagian yang lebih banyak berbanding dengan rekabentuk asal, namun begitu rekabentuk semula tetap mempunyai kelebihan dari segi kemudahan fungsi dan peratusan kecekapan rekabentuk. Akhirnya, pembaikan rekabentuk kerusi roda akan mampu untuk memenuhi kehendak dan kepuasan khususnya para pengguna.
DEDICATION

Firstly, thanks to Allah S.W.T for the opportunity to finish this project. I owe this project and my true happiness to my beloved parents, Abdul Rashid Bin Harun and Salasiah Binti Ibrahim. Since the day I started joining this University until today, they are very caring and supporting for me.
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# TABLE OF CONTENTS

Abstract ........................................................................................................................................... i
Abstrak........................................................................................................................................ ii
Dedication ........................................................................................................................................ iii
Acknowledgements ......................................................................................................................... iv
Table of Contents ............................................................................................................................ v
List of Figures ................................................................................................................................... ix
List of Tables .................................................................................................................................... xi
List of Sign and Symbol .................................................................................................................... xii

1.0 INTRODUCTION ............................................................................................................................. 1

1.1) General Introduction .................................................................................................................... 1

1.2) Objective .................................................................................................................................... 2

1.3) Problem Statement ...................................................................................................................... 2

1.4) Scope of Project .......................................................................................................................... 3

2.0 LITERATURE REVIEW .................................................................................................................... 4

2.1) Introduction ................................................................................................................................ 4

2.2) Wheelchair development ........................................................................................................... 5

2.2.1) Market research and industrial surveys ..................................................................................... 6

2.2.2) Classes of Manual Wheelchairs ............................................................................................... 6

2.2.3) Existing manual wheelchairs design ......................................................................................... 10

2.2.4) Wheelchair Common Materials ............................................................................................. 13

2.2.5) Advantages of manual wheelchairs ......................................................................................... 14
2.3) Concurrent Engineering ................................................................. 15
   2.3.1) Definition of Concurrent Engineering ........................................... 16
   2.3.2) Objectives of Concurrent Engineering ........................................... 17
   2.3.3) Fundamental of Concurrent Engineering ........................................ 18
   2.3.4) Advantages of CE ................................................................. 19
   2.3.5) Concurrent Engineering Tools ................................................... 20
       2.3.5.1) Quality Function Deployment (QFD) ........................................ 20
       2.3.5.2) Design For Assembly (DFA) ............................................... 22
   2.3.6) TeamSET ........................................................................... 30

3.0 METHODOLOGY .............................................................................. 33
   3.1) Method of study ................................................................. 33
   3.2) Project Flow Chart for PSM 1 .................................................. 34
       3.2.1) Explanation on Project Flow ................................................. 35
   3.3) Project Flow Chart for PSM 2 .................................................. 36
       3.2.1) Explanation on Project Flow ................................................. 37

4.0 QFD IMPLEMENTATION ................................................................. 38
   4.1) Introduction to QFD ............................................................... 38
   4.2) QFD Project Case Study ......................................................... 39
   4.3) Methodology Implementation of QFD ........................................... 40
   4.4) Construction QFD Matrix ......................................................... 41
       4.4.1) Customer Requirement Section .......................................... 42
       4.4.2) Planning Matrix Section ..................................................... 42
4.4.3) Technical Requirement section ............................................. 43
4.4.4) Interrelationship Section ..................................................... 43
4.4.5) Roof Section ................................................................. 45
4.4.6) Target Section ............................................................... 46
4.4.7) Propose New Concept ....................................................... 46

4.5) Gathering Information from VOC ........................................... 47
4.5.1) Questionnaire Objective .................................................... 48
4.5.2) Result From Questionnaire ............................................... 48
4.5.3) User Background ............................................................ 49
4.5.4) Graph Analysis ............................................................... 50
4.5.5) Scales of Rating .............................................................. 54
4.5.6) Complaint .................................................................. 56
4.5.7) Technical Requirement Section ......................................... 57

4.6) Final Construction HOQ ....................................................... 60
4.6.1) Result of Priority Tech. Requirement of Man. Wheelchair ....... 62

5.0 DFA ANALYSIS .................................................................. 63

5.1) Introduction of DFA Analysis ................................................. 63
5.2) Implementation of DFA Analysis ............................................ 64
5.3) Methodology Implementation on DFA Analysis ....................... 65
5.3.1) TeamSET Process Flow ................................................... 66
5.3.2) TeamSET Database Process Flow ..................................... 67
5.4) Exploded Parts of Man. Wheelchair ......................................... 71
APPENDICES

A  Gantt Chart for PSM 1 & 2
B  Standard Wheelchair and Main Components
C  Questionnaire Form
D  Detail Drawing for Redesign Manual Wheelchair
E  TeamSET Result Sheets
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2</td>
<td>Civil War wheelchair</td>
<td>5</td>
</tr>
<tr>
<td>2.2.2</td>
<td>Side view schematic of wheelchair</td>
<td>9</td>
</tr>
<tr>
<td>2.2.3</td>
<td>Standard wheelchair and main components</td>
<td>10</td>
</tr>
<tr>
<td>2.3.5.2.a</td>
<td>Pressed or molded parts (before and after)</td>
<td>23</td>
</tr>
<tr>
<td>2.3.5.2.b</td>
<td>Building in self-fastening features</td>
<td>24</td>
</tr>
<tr>
<td>2.3.5.2.c</td>
<td>Decrease ambiguity in part/subassembly orientation</td>
<td>25</td>
</tr>
<tr>
<td>3.2</td>
<td>Flow Chart of job planning</td>
<td>34</td>
</tr>
<tr>
<td>3.3</td>
<td>Flow Chart of job planning</td>
<td>36</td>
</tr>
<tr>
<td>4.2</td>
<td>Process Flow of QFD Implementation</td>
<td>39</td>
</tr>
<tr>
<td>4.4</td>
<td>Basic Element HOQ</td>
<td>41</td>
</tr>
<tr>
<td>4.4.1</td>
<td>Basic of HOQ Customer Requirement</td>
<td>42</td>
</tr>
<tr>
<td>4.4.2</td>
<td>Basic of HOQ of Matrix Selection</td>
<td>42</td>
</tr>
<tr>
<td>4.4.3</td>
<td>Example of Tech. Requirement</td>
<td>43</td>
</tr>
<tr>
<td>4.4.4.a</td>
<td>Example of Relationship</td>
<td>44</td>
</tr>
<tr>
<td>4.4.4.b</td>
<td>Common Relationship Values</td>
<td>44</td>
</tr>
<tr>
<td>4.4.5.a</td>
<td>Co relationship symbol</td>
<td>45</td>
</tr>
<tr>
<td>4.5.4.a</td>
<td>Gender</td>
<td>50</td>
</tr>
<tr>
<td>4.5.4.b</td>
<td>Age</td>
<td>51</td>
</tr>
<tr>
<td>4.5.4.c</td>
<td>Purpose using wheelchair</td>
<td>52</td>
</tr>
<tr>
<td>4.5.4.d</td>
<td>Usage Duration</td>
<td>53</td>
</tr>
<tr>
<td>Section</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>4.5.7</td>
<td>Major Component on Present Wheelchair</td>
<td>58</td>
</tr>
<tr>
<td>5.3.1</td>
<td>The process flow in developing TeamSET database</td>
<td>66</td>
</tr>
<tr>
<td>5.3.2.a</td>
<td>Product maintaining projects, products and design scenarios</td>
<td>67</td>
</tr>
<tr>
<td>5.3.2.b</td>
<td>Product Breakdown Structure</td>
<td>68</td>
</tr>
<tr>
<td>5.3.2.c</td>
<td>Assembly window</td>
<td>69</td>
</tr>
<tr>
<td>5.3.2.d</td>
<td>DFA analysis for assembly parts</td>
<td>70</td>
</tr>
<tr>
<td>5.4.1</td>
<td>Tree Structure of Main frame</td>
<td>71</td>
</tr>
<tr>
<td>5.4.1.1</td>
<td>Tree Structure of Brake</td>
<td>72</td>
</tr>
<tr>
<td>5.4.2</td>
<td>Tree Structure of Supporting Part</td>
<td>73</td>
</tr>
<tr>
<td>5.4.3</td>
<td>Tree Structure of Driving Part</td>
<td>75</td>
</tr>
<tr>
<td>5.4.3.1</td>
<td>Tree Structure of Caster</td>
<td>76</td>
</tr>
<tr>
<td>5.4.3.2</td>
<td>Tree Structure of Rear Tyre</td>
<td>77</td>
</tr>
<tr>
<td>5.5.1.a</td>
<td>Summary result for Frame Part</td>
<td>78</td>
</tr>
<tr>
<td>5.5.1.b</td>
<td>Summary result for Driving Part</td>
<td>79</td>
</tr>
<tr>
<td>5.5.1.c</td>
<td>Summary result for Supporting Part</td>
<td>81</td>
</tr>
<tr>
<td>5.6</td>
<td>Design proposal of Manual Wheelchair</td>
<td>83</td>
</tr>
<tr>
<td>5.6.1.1</td>
<td>Tree Structure of Frame</td>
<td>84</td>
</tr>
<tr>
<td>5.6.1.2</td>
<td>Tree Structure Supporting Part</td>
<td>85</td>
</tr>
<tr>
<td>5.6.1.3</td>
<td>Tree Structure for Driving Parts</td>
<td>86</td>
</tr>
<tr>
<td>5.7.a</td>
<td>TeamsSET analysis for Frame part</td>
<td>87</td>
</tr>
<tr>
<td>5.7.b</td>
<td>TeamsSET analysis for Driving parts</td>
<td>88</td>
</tr>
<tr>
<td>5.7.c</td>
<td>TeamsSET analysis for Supporting parts</td>
<td>90</td>
</tr>
<tr>
<td>6.1.1.a</td>
<td>Adjustability of Armrest</td>
<td>93</td>
</tr>
<tr>
<td>Section</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>--------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>6.1.1.b</td>
<td>Height Adjustability</td>
<td>94</td>
</tr>
<tr>
<td>6.1.1.c</td>
<td>Adjustability of Footrest</td>
<td>95</td>
</tr>
<tr>
<td>6.1.1.d</td>
<td>Adjustability of Footrest</td>
<td>95</td>
</tr>
<tr>
<td>6.1.1.e</td>
<td>Adjustability of Backrest and Seat</td>
<td>96</td>
</tr>
</tbody>
</table>
LIST OF TABLES

4.5.3 Summary of wheelchair user background 49
4.5.5 Scales of Rating 54
4.5.5.b Summary of Responses Importance from Respondent 55
4.5.6 Number of Complaint 56
4.5.7.a Main Component of Manual Wheelchair 57
4.5.7.b Technical Requirement 59
4.6 Priority Technical Requirement 61
5.4.1 Parts consists of frame 72
5.4.1.1 Brake Parts 73
5.4.2 Parts consists of Supporting Parts 74
5.4.3.1 Parts consists of Caster Tyre 76
5.4.3.2 Parts consists of Rear Tyre 77
5.5.1.a Summary analysis for Frame 79
5.5.1.b Summary analysis for Driving parts 80
5.5.1.c Summary analysis for Supporting parts 82
5.7.a Summary analysis for Frame 88
5.7.b Summary analysis Driving Parts 89
5.7.c Summary analysis for Supporting Parts 91
6.2 Comparison of Existing and Redesign Wheelchair 98
<table>
<thead>
<tr>
<th>SIGN</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE</td>
<td>Concurrent Engineering</td>
</tr>
<tr>
<td>QFD</td>
<td>Quality Function Deployment</td>
</tr>
<tr>
<td>HOQ</td>
<td>House of Quality</td>
</tr>
<tr>
<td>DFA</td>
<td>Design for Assembly</td>
</tr>
<tr>
<td>VOC</td>
<td>Voice of Customer</td>
</tr>
<tr>
<td>PSM</td>
<td>Projek Sarjana Muda</td>
</tr>
</tbody>
</table>
CHAPTER 1
INTRODUCTION

1.1 General Introduction

Product lifecycle is being reduced drastically due to rapid changes in technology and customer requirements. To enable product lifecycle to be reduced, Concurrent Engineering (CE) technique needs to be applied. Currently, the implementation of Concurrent Engineering (CE) tools are applied either manually or computer-aided. Most of the applied interested in implementing CE are hindered by lack of clear guidelines or procedures and no integration of isolated design and manufacturing teams. The objective of the project is to integrate some CE tools in analyzing a product to get the full benefit of the implementation. The advantages of the integration are to decrease the number of part design and indirectly to reduce cost and time. At the same time, it fulfills customer’s requirement.

In this project, CE has been applied in developing the manual wheelchair. Generally, there are many types of wheelchair exist in market nowadays. Some of them were designed to suit the requirements especially to the users in such many ways and purposes. But the fact is how many of the designs are totally suited to the customer’s needs? To attain the best design with the lowest cost of manufacturing is not an easy task, but with the application of CE tools, the problems could be minimized. Besides that, the design also must be concerned to
the customer needs and requirements in order to achieve high rank of market selling.

1.2 Objective

Wheelchair has an important role in order to help disable people to allow a greater mobility by decreasing their limitations of travel. The objectives of this project are as follows:

a) To redesign and improve existing design of wheelchair by applying the concurrent engineering method.

b) To identify the customer requirements and needs regarding product to be studied.

c) To achieve the better design efficiency for redesign product compared to the existing product.

1.3 Problem Statement

Nowadays, the manufacturing industries are concerned about producing a high quality product with the lowest cost. So, this is the major key in business to gain high profit and succeed. To achieve the goal, most industries applied the CE tools in developing their products.

In present, there are many types of wheelchair exist in market place. They were designed in such many ways and purposes. Some of them were designed with well good looking and some of them just with simple design. But did we realize that certain parts of the wheelchair are just being design without any purposes? Instead to make the wheelchair look more gorgeous and nice looking. It is not necessary to design a product with a good looking shape, but lack of purposes.
Another problem also encountered, the design of the wheelchair is too complicated with some unnecessary parts available. Sometimes the parts are difficult to handle and the design can be considered as a failed design.

This project focused on the development of a wheelchair design by applying the CE tools. Thus, to overcome the problems encountered, this project will run through appropriate CE tools in the chapter 4 and 5 ahead.

1.4 Scope of Study

i. Case study

A wheelchair has been selected as a case study for this project and had the potential to be redesigned by applying the appropriate CE tools.

ii. Design Tool (SolidWorks Software)

The tool selected for drawing the wheelchair is SolidWork. Users can easily generate drawings from a model. Photorealistic renderings and animations that allow communicating how future products will look and perform early in the development cycle

iii. Quality Function Deployment (QFD)

QFD will be used to identify customer requirement. It will be done through a survey. The basic idea is to translate customer’s requirement into the appropriate technical requirement for each stage of product development and production.

iv. Design for Assembly (DFA) – TeamSET

DFA is a systematic methodology that reduces manufacturing costs, total number of parts in a product, and etcetera. For this project, the software called TeamSET is used to analyze the design efficiency for both existing and redesign manual wheelchair.
CHAPTER 2
LITERATURE REVIEWS

2.1 Introduction

To develop this project, there are certain important CE tools that have been applied such as Quality Function Deployment (QFD) and Design for Assembly (DFA). These two important CE tools are very useful especially to the industry. This chapter described about the history of wheelchair, the definition of concurrent engineering and the approach of QFD and DFA, including the application of the engineering software called TeamSET.
2.2 Wheelchair Development

Wheelchairs in one form or another have been in use for many centuries, with one of the earliest models recorded by an engraving on a Chinese sarcophagus dated 6 AD. Self-propelling chairs were a later invention, but by the time of the American Civil War records show that the war wounded used wooden chairs (figure 2.2) with large front wheels and small rear casters [2].

![Civil war wheelchair](image)

Figure 2.2: Civil war wheelchair

Over the years, changes in design and structure reflected the introduction of new materials, advances in medical science, improvements in access and the environment and changes in social attitudes.

The arrival of the automobile resulted in demand for a portable model. In 1932, following a mining accident, Herbert A. Everest, an American mining engineer, collaborated with Harry C. Jennings, a mechanical engineer, to design and manufacture a relatively 'light-weight' folding wheelchair.