



**Faculty of Mechanical and Manufacturing Engineering
Technology**

**STUDY CHAIR'S DESIGN OPTIMIZATION USING DESIGN FOR
MANUFACTURE AND ASSEMBLY METHOD (DFMA)**

MUHAMMAD ADAM AIMAN BIN MAT DAUD

B091910060

000713-01-0509

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor Degree of Mechanical Engineering Technology with Honours**

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA

TAJUK: **STUDY CHAIR'S DESIGN OPTIMIZATION USING DESIGN FOR MANUFACTURE AND ASSEMBLY METHOD (DFMA)**

SESI PENGAJIAN: **2022/23 Semester 1**

Saya: **MUHAMMAD ADAM AIMAN BIN MAT DAUD**

mengaku membenarkan tesis ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. ****Sila tandakan (✓)**

- SULIT** (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
- TERHAD** (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
- TIDAK TERHAD**



Disahkan oleh:



DR. ROSIDAH BINTI JAAFAR
Pensyarah Kanan

Cop Rasmi: **Universiti Teknikal Malaysia Melaka**
Hang Tuah Jaya
76100 Durian Tunggal, Melaka

Alamat Tetap:

NO.15, JALAN MAWAR 21,

TAMAN MAWAR,

81700 PASIR GUDANG, JOHOR

Tarikh: 20 / 01 / 2023

Tarikh: 20-1-2023

****** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I declare that this Choose an item. entitled “ Study Chair’s Design Optimization Using Design for Manufacture and Assembly Method (DFMA)” 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

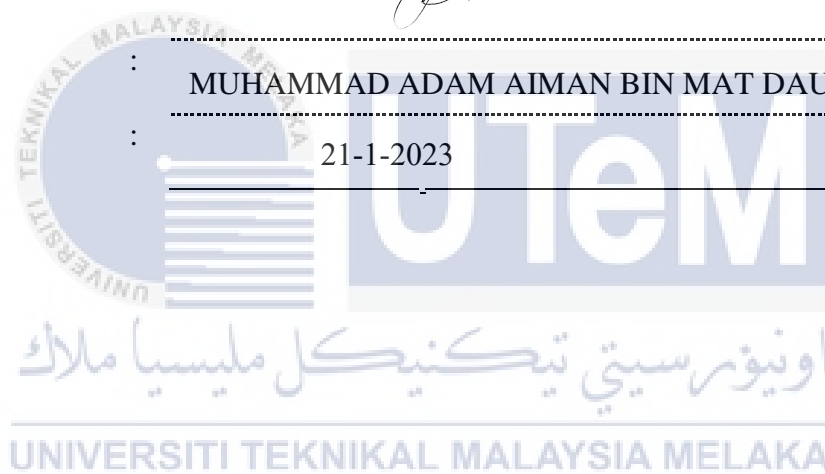
:

MUHAMMAD ADAM AIMAN BIN MAT DAUD

Date

:

21-1-2023



APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor Degree of Mechanical Engineering Technology with Honours.

Signature

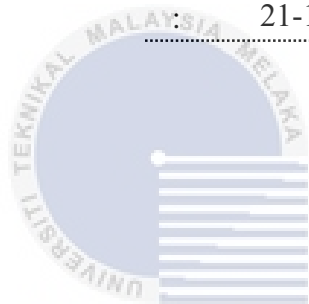

DR. ROSIDAH BINTI JAAFAR
Pensyarah Kanan
Fakulti Teknologi Kejuruteraan Mekanikal dan Pembuatan
Universiti Teknikal Malaysia Melaka
Hang Tuah Jaya
76100 Durian Tunggal, Melaka

Supervisor Name

: DR. ROSIDAH BINTI JAAFAR

Date

: 21-1-2023



اونيورسيتي تيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEDICATION

*For my beloved mother, Nor Liza Binti Isa and my father, Mat Daud Bin Deraman also to
my big brother Muhammad Danial Aniq Bin Mat Daud.*



ABSTRACT

The goal of this project is to show how Design Manufacture and Assembly (DFMA) may be used in the product development process. The study chair is the product chosen for use in the DFMA process in this project. The goal of this research is to minimise the number of study chair components while also examining the materials and techniques used in the manufacturing of the study chair. Furthermore, the DFMA approach was chosen because of its capacity to quantify the labour cost necessary in the manufacturing process. Boothroyd-Dewhurst DFMA software was utilised to make the analysis easier. This software was chosen because it is successful in reducing the number of components in a product and is easy to use for designers. In conclusion, the DFMA is utilised as the foundation for concurrent engineering studies to offer recommendations to product designers. In addition, using the form characteristic in the compatibility chart as a guide, Design for Manufacturing (DFM) was used to select the best method and material. Furthermore, the Design for Assembly (DFA) stage is an important tool for improving product design. Several suggestions have been made to improve the project, including a study of the possibility for geometry interface part or component data to be connected to the software.

ABSTRAK

Matlamat projek ini adalah untuk menunjukkan bagaimana Reka Bentuk Pembuatan dan Pemasangan (DFMA) boleh digunakan dalam proses pembangunan produk. Kerusi kajian adalah produk yang dipilih untuk digunakan dalam proses DFMA dalam projek ini. Matlamat penyelidikan ini adalah untuk meminimumkan bilangan komponen kerusi kajian sambil juga memeriksa bahan dan teknik yang digunakan dalam pembuatan kerusi kajian. Tambahan pula, pendekatan DFMA dipilih kerana keupayaannya untuk mengukur kos buruh yang diperlukan dalam proses pembuatan. Perisian Boothroyd-Dewhurst DFMA telah digunakan untuk menjadikan analisis lebih mudah. Perisian ini dipilih kerana berjaya mengurangkan bilangan komponen dalam produk dan mudah digunakan untuk pereka. Kesimpulannya, DFMA digunakan sebagai asas untuk kajian kejuruteraan serentak untuk menawarkan cadangan kepada pereka produk. Di samping itu, menggunakan ciri borang dalam carta keserasian sebagai panduan, Reka Bentuk untuk Pembuatan (DFM) digunakan untuk memilih kaedah dan bahan terbaik. Tambahan pula, peringkat Reka Bentuk untuk Perhimpunan (DFA) adalah alat penting untuk meningkatkan reka bentuk produk. Beberapa cadangan telah dibuat untuk memperbaiki projek, termasuk kajian kemungkinan bahagian antara muka geometri atau data komponen disambungkan ke perisian.

ACKNOWLEDGEMENTS

In Allah's name, the Most Merciful, the Most Gracious

First and foremost, I want to thank Allah the Almighty, my Creator and Sustainer, for all I have received from the beginning of my life. I'd like to thank Universiti Teknikal Malaysia Melaka (UTeM) for providing me with a conducive research atmosphere. Also, thank you for the financial assistance provided by the Malaysian Ministry of Higher Education (MOHE)

My major supervisor is Dr. Rosidah Binti Jaafar of the Faculty of Mechanical and Manufacturing Technologies at Universiti Teknikal Malaysia Melaka (UTeM), and I am thankful for all her assistance, direction, and inspiration. Her inexhaustible patience in mentoring and giving priceless knowledge will be remembered for the rest of her life.

In addition to my supervisor, I'd want to thank my friends and students for their constant support. I would never have been able to finish my thesis without the advice of my supervisor, the help of friends, and the support of my family. For their steadfast love, dream, and sacrifice throughout my life, I owe my parents a profound debt of gratitude. I appreciate all they've done to assist me in my success. Their patience motivates me to try harder to achieve my objectives. I couldn't find the perfect words to thank them for their dedication, support, and confidence in my ability to achieve my objectives.

Finally, I'd want to show my appreciation to anybody who directly or indirectly contributes to and aids me with my final year project. I'd want to express my gratitude to everyone for their excellent input and recommendations, which were critical to the study's success.

اوتور سیتی تکنیکل ملیسیا ملاک
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

TABLE OF CONTENTS

	PAGE
DECLARATION	
APPROVAL	
DEDICATION	
ABSTRACT	i
ABSTRAK	ii
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	vi
LIST OF FIGURES	viii
LIST OF SYMBOLS AND ABBREVIATIONS	xi
LIST OF APPENDICES	12
CHAPTER 1 INTRODUCTION	13
1.1 Background	13
1.2 Problem Statement	14
1.3 Research Objective	16
1.4 Scope of Research	16
CHAPTER 2 LITERATURE REVIEW	17
2.1 Introduction	17
2.2 Methodology for Design For Manufacturing and Assembly (DFMA)	18
2.3 Design for Manufacturing and Assembly (DFMA)	20
2.3.1 History of DFMA	20
2.4 What is DFMA?	22
2.5 Advantages of applying DFMA	22
2.6 Design for Manufacture (DFM)	24
2.7 Design for Assemble (DFA)	24
2.8 DFMA Methodologies	25
2.8.1 The Boothroyd-Dewhurst Method	25
2.9 Solidwork CAD Software	26
2.10 Summary	28
CHAPTER 3 METHODOLOGY	29
3.1 Introduction	29
3.2 Existing analysis of study chair	31
3.3 Design Process	32
3.4 Design for Assembly (DFA) study chair	33
3.5 Design Efficiency	35

3.6	Design for Manufacture (DFM) study chair	35
3.7	Redesign and analysis of study chair	36
3.8	Part of the study chair	37
3.8.1	Wheel	38
3.8.2	Chair base	38
3.8.3	Chair base cover	39
3.8.4	Gas cylinder	39
3.8.5	Chair mechanism	40
3.8.6	Seat cushion	40
3.8.7	Lumbar support	41
3.8.8	Backrest	41
3.8.9	Armrest	42
3.8.10	Knob	42
3.8.11	Headrest	43
3.8.12	Headrest handle	43
3.8.13	Screw	44
3.9	Preliminary findings.	44
3.10	Summaary	45
CHAPTER 4 RESULTS AND DISCUSSION		46
4.1	Introduction	46
4.2	The structure chart of the original design	46
4.3	DFA analysis of the original design	47
4.3.1	Summary of the original design analysis	49
4.3.2	Guidelines from the DFA software	51
4.3.3	Implementing the redesign suggestions of the DFA software	53
4.4	DFA analysis of the redesigned product	55
4.4.1	Summary of the DFA redesign analysis	55
4.4.2	Comparing the original design and redesign product	57
4.5	DFM analysis	59
4.5.1	DFM analysis for Original Design	59
4.6	Analysis for material use for redesign	76
4.7	Summary	77
CHAPTER 5 CONCLUSION AND RECOMMENDATIONS		78
5.1	Conclusion	78
5.2	Recommendations	79
5.3	Project Potential	79
REFERENCES		80
APPENDICES		85

LIST OF TABLES

TABLE	TITLE	PAGE
Table 2.1:	Comparison DFMA method for each product.	19
Table 3.2:	Components or parts of the study chair	31
Table 3.3:	Part specification.	34
Table 3.4:	Existing Design for Manufacturing.	36
Table 4.1:	Assembly worksheet (Original design)	48
Table 4.2:	General Summary (Original design)	49
Table 4.3:	Breakdown of the costs (Original design)	49
Table 4.4:	Breakdown of the time (Original design)	49
Table 4.5:	Manual Assembly time (s)	50
Table 4.6:	Parts reduction.	52
Table 4.7:	Operation reduction.	52
Table 4.8:	Insertion difficulties	52
Table 4.9:	Handling difficulties	52
Table 4.10:	Assembly worksheet of the redesign	56
Table 4.11:	General summary (comparison)	57
Table 4.12:	Comparing the costs breakdown	58
Table 4.13:	Comparing the time breakdown	58
Table 4.14:	Summary of wheel manufacturer	60
Table 4.15:	Summary of base manufacturer (Original Design)	61
Table 4.16:	Summary of base manufacturer (Redesign)	62
Table 4.17:	Summary of base cover manufacturer	64
Table 4.18:	Summary of gas cylinder manufacturer	65
Table 4.19:	Summary of mechanism manufacturer	66

Table 4.20:Summary of #3 socket head cap screw manufacturer	67
Table 4.21:Summary of seat manufacturer	68
Table 4.22:Summary of armrest manufacturer	69
Table 4.23:Summary of backrest manufacturer	70
Table 4.24:Summary of lumbar support manufacturer	71
Table 4.25:Summary of 1 in. hex head bolt manufacturer	72
Table 4.26:Summary of headrest manufacturer	73
Table 4.27:Summary of headrest support manufacturer	74
Table 4.28:Summary of headrest support manufacturer	75

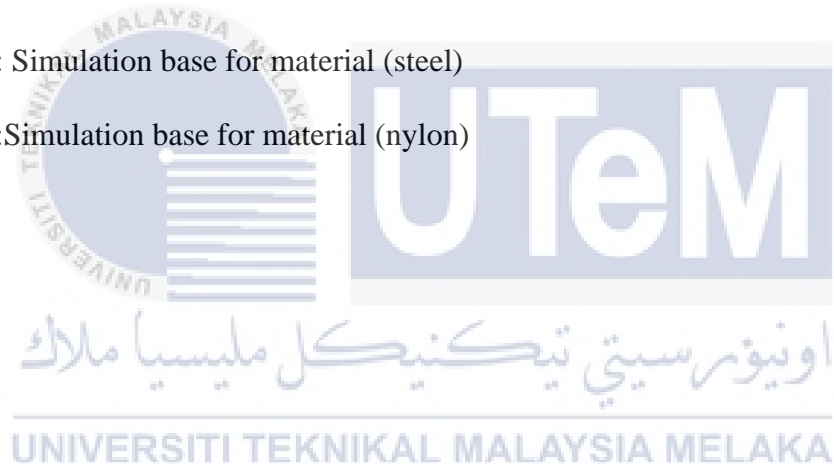


LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 1.1:	Type of DFMA method.	13
Figure 1.2:	Example type of study chairs.	15
Research Design Figure 3.1:	Research Design flow chart.	30
Figure 3.2:	Original design and exploded view study chair	32
Figure 3.3:	Redesign and exploded view study chair	37
Figure 3.4:	Wheel	38
Figure 3.5:	Base	38
Figure 3.6:	Chair base cover	39
Figure 3.7:	Gas cylinder	39
Figure 3.8:	Chair mechanism	40
Figure 3.9:	Seat cushion	40
Figure 3.10:	Lumbar support	41
Figure 3.11:	Backrest	41
Figure 3.12:	Armrest	42
Figure 3.13:	Knob	42
Figure 3.14:	Headrest	43
Figure 3.15:	Headrest handle	43
Figure 3.16:	Screw	44
Figure 4.1:	(a) The structure chart; (b) The minimum-part criteria (Original Design)	47
Figure 4.2:	Breakdown of cost per product (original design)	50
Figure 4.3:	Breakdown of time per product (original design)	51
Figure 4.4:	The redesigned of armrest part	53
Figure 4.5:	The redesign of lumbar support part	54

Figure 4.6:The redesign structure chart	55
Figure 4.7:Breakdown of cost per product (redesign)	56
Figure 4.8:Breakdown of time per product (redesign)	57
Figure 4.9:Comparing the cost per product breakdown	58
Figure 4.10:Comparing the time per product breakdown	59
Figure 4.11:Structure chart for operation and machine tool	60
Figure 4.12:Breakdown of the cost wheel	60
Figure 4.13:Structure chart operation and machine tools (Original Design)	61
Figure 4.14:Breakdown of the cost base (Original Design)	61
Figure 4.15:Structure chart operation and machine tools (Redesign)	62
Figure 4.16:Breakdown of the cost base (Redesign)	62
Figure 4.17:Structure chart operation and machine tools	64
Figure 4.18:Breakdown of the cost base cover	64
Figure 4.19:Structure chart operation and machine tools	65
Figure 4.20:Breakdown of the cost gas cylinder	65
Figure 4.21:Structure chart operation and machine tools	66
Figure 4.22:Breakdown of the cost mechanism	66
Figure 4.23:Structure chart operation and machine tools	67
Figure 4.24:Breakdown of the cost #3 socket head cap screw	67
Figure 4.25:Structure chart operation and machine tools	68
Figure 4.26:Breakdown of the cost seat	68
Figure 4.27:Structure chart operation and machine tools	69
Figure 4.28:Breakdown of the cost armrest	69
Figure 4.29:Structure chart operation and machine tools	70
Figure 4.30:Breakdown of the cost backrest	70

Figure 4.31:Structure chart operation and machine tools	71
Figure 4.32:Breakdown of the cost lumbar support	71
Figure 4.33:Structure chart operation and machine tools	72
Figure 4.34:Breakdown of the cost 1 in. hex head bolt	72
Figure 4.35:Structure chart operation and machine tools	73
Figure 4.36:Breakdown of the cost headrest	73
Figure 4.37:Structure chart operation and machine tools	74
Figure 4.38:Breakdown of the cost headrest support	74
Figure 4.39:Structure chart operation and machine tools	75
Figure 4.40:Breakdown of the cost knob	75
Figure 4.41: Simulation base for material (steel)	76
Figure 4.42:Simulation base for material (nylon)	76



LIST OF SYMBOLS AND ABBREVIATIONS

B

Boothroyd Dewhurst, Inc

(BDI), 25

Boothroyd-Dewhurst

(B-D), 26

C

cost

(DfC), 21

D

Design for Assembly

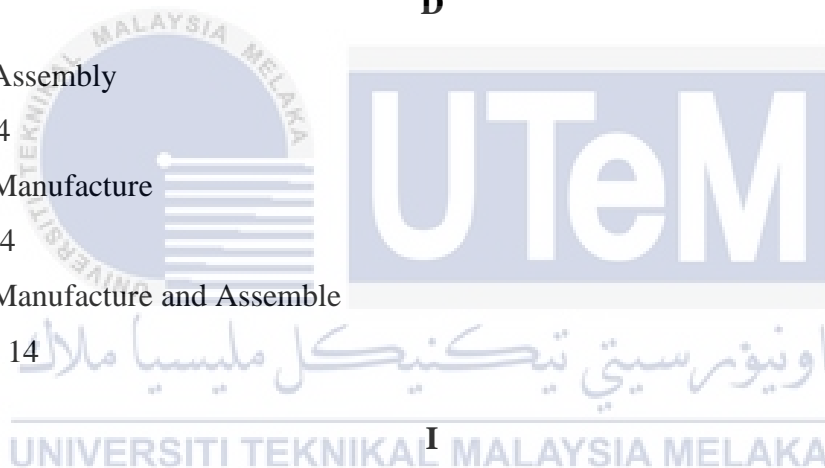
(DFA), 14

Design for Manufacture

(DFM), 14

Design for Manufacture and Assemble

(DFMA), 14



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

inspection

(DfI), 21

V

variability

(DfV), 21

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
APPENDIX A:	Gantt Chart FYP 1	85
APPENDIX B:	Gantt chart FYP 2	86
APPENDIX C:	Dimension for wheel	87
APPENDIX D:	Dimension for base	87
APPENDIX E:	Dimension for cover	88
APPENDIX F:	Dimension for gas cylinder	88
APPENDIX G:	Dimension for mechanism	89
APPENDIX H:	Dimension for seat	89
APPENDIX I:	Dimension for lumbar support	90
APPENDIX J:	Dimension for backrest	90
APPENDIX K:	Dimension for armrest	91
APPENDIX L:	Dimension for knob	91
APPENDIX M:	Dimension for headrest	92
APPENDIX N:	Dimension for headrest support	92
APPENDIX O:	Dimension for screw	93
APPENDIX P:	DFA software panel	93
APPENDIX Q:	DFM software panel	94

CHAPTER 1

INTRODUCTION

1.1 Background

DFMA stands for “Design for Manufacture / Manufacturing and Assembly”. DFMA is one of the main design approaches that focusses on ease of manufacture and efficiency of assemble product that meet the customers requirement and easily produce products. Its purpose is to reduce costs and minimum time by simplifying the design of a product it is possible to manufacture and assemble it more efficiently. DFMA combines two methodologies that are Design for Manufacture (DFM) and Design for Assembly (DFA).

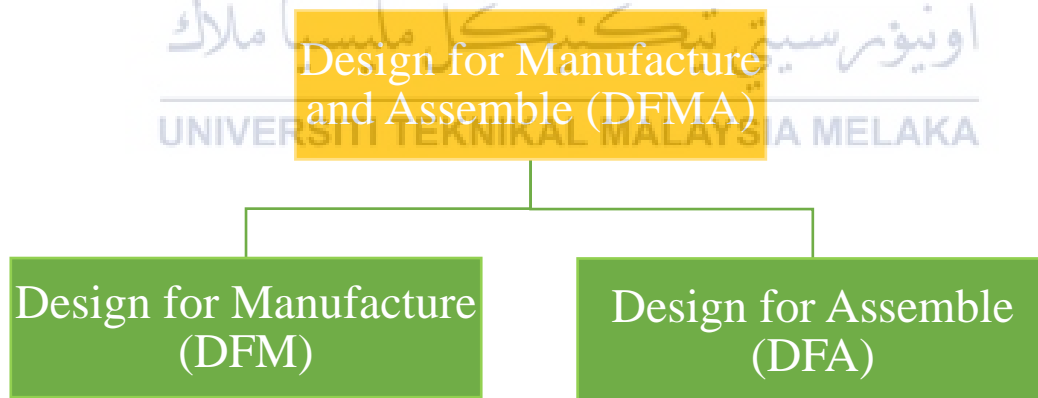


Figure 1.1: Type of DFMA method.

Design for Manufacture (DFM) is considered as design for reduce manufacture process of the collection of parts that will form the product after assembly. Meanwhile, Design for Assembly (DFA) is all about reducing the cost and time to assemble of the parts into a finished product. Technically, DFMA is a systematic design procedure to analyze and quantify product design from the point of view of assembly and manufacture, minimize the cost and time of the production and fulfill customer's requirement.

1.2 Problem Statement

Nowadays, people are more wanting to have something that simple, easy and less costly in their daily requirement. Each study chair has a different design in terms of manufacturing and assembly which is related to the number of parts of a product. Some of study chair designs have many parts such as headrest some of it didn't have headrest. It consists of many a part and takes long time to assemble the product.

For this research the product study chair that has headrest will analyse to make it simple and reduce assemble time. In analyse the study chair, the most important things that need to be concerned is the existing design of the study chair. Besides that, some of the part for study chair can eliminate or reduce some components to make it minimize the assembly time of the study chair.

Therefore, research need to be carried out by using Design for Manufacture and Assemble (DFMA) method to identify the design efficiency of the product so that it could help manufacturer to improve the current study chair design. Manufacturer can improve the product by minimizing and simplifying some of the part and reduce assembly time to get maximum design efficiency of the product.

The DFMA method consists of Boothroyd Dewhurst method that could help to suggest the idle possible way to reduce the part of study chair, as well as the assembly time and the

cost of production. From that, the existing design of the study chair will improve in the after design (redesign) of the study chair.



Figure 1.2: Example type of study chairs.

1.3 Research Objective

The main aim of this research is to redesign the product by reduce the cost of product and time assemble product while maintaining product performance. Specifically, the objectives are as follows:

- a) To investigate design of study chair using DFMA method.
- b) To optimise study chair design using DFA method for original design and redesign product.
- c) To identify the suitable material for redesign and reduce cost manufacturer using DFM method.

1.4 Scope of Research

The scope of this research are as follows:

- To analyze and compare the design efficiency for both current design of the product and the redesign of the study chair.
- To reduce the number of components or parts in the current study chair's using the DFMA procedure without altering their features.
- To estimate the manufacturing cost, it is necessary to give the cost of material, hourly rate for manufacturing and labor cost of study chair.

CHAPTER 2





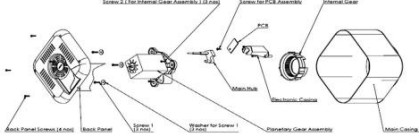

LITERATURE REVIEW

2.1 Introduction

According to research, a complete DFMA analysis assisted in providing a categorised approach to the costs to be infused with each division inside the company. This allows product designers to make the most use of all available resources. As a result, more efficient products at lower costs can be designed, increasing sales. According to Dewhurst et al, early cost estimation in product design is meant to serve as the foundation for design analysis for efficient manufacturing. By lowering the number of pieces in the product and redesigning some elements to minimise the amount of material needed, the DFMA technique may be utilised efficiently to reduce total manufacturing costs. Recent research has also shown that the material selection process might assist product designers in determining which elements of materials are important in their decision. A systematic way to evaluate how effectively a product is designed from an assembly standpoint is called Design for Assembly assessment. A research looks at a framework for automating the DFA assessment technique, which is an important step in creating a concurrent design environment. Assembly sequence creation, assembly features extraction, assembly code and other essential operations generation, data manipulation and computation, and re-design recommendation are the modules required for this. Recent DFMA research have focused on devices such as diesel engines, washing machines, and refrigerators, which have proven to be more successful due to their widespread use in daily life. Another

motivation to include consumer items in the DFMA technology is the large number of products available throughout the world.

2.2 Methodology for Design For Manufacturing and Assembly (DFMA)

Author	Product	Method	Result
<ul style="list-style-type: none"> C. D. Naiju Jayakrishnan Vinod Pranaw. V. Warrier 	<p>Pedestal fan</p>  <p>Existing Pedestal Fan</p>	<p>DFMA for early cost estimation</p>	 <p>Redesigned Pedestal Fan</p>
<ul style="list-style-type: none"> Y Ngatillah 	<p>Emergency lamp</p>  <p>Product lamp early</p>	<p>DFMA for Product Development</p>	 <p>View of design lamp</p>
<ul style="list-style-type: none"> Akshay Harlalka C. D. Naiju Mukund Nilakantan Janardhanan Izabela Nielsen 	<p>In-market food processor</p>  <p>Original product of the main processor machine.</p>	<p>DFMA for manufacturing cost reduction</p>	 <p>Redesign main processor machine.</p>

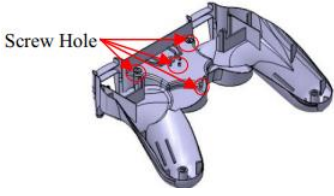
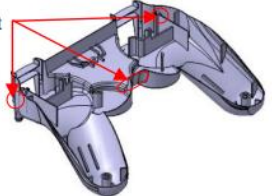




<ul style="list-style-type: none"> Nor Nasyitah Mohammad 	<p>Joystick</p>  <p>Screw Hole</p> <p>Original joystick design</p>	<p>Compare the design efficiency</p>	 <p>Snap-fit</p> <p>Redesign joystick</p>
<ul style="list-style-type: none"> C. D. Naiju, Pranav. V. Warrier V. Jayakrishnan 	<p>Shopping cart</p>  <p>Existing shopping cart model</p>	<p>Cost reduction using DFMA</p>	 <p>Re-design shopping cart model</p>
<ul style="list-style-type: none"> G. F. Batalha 	<p>Fuel intake cover</p>  <p>Design before DFMA</p>	<p>Reducing number of parts</p>	 <p>Design after DFMA</p>



Table 2.9: Comparison DFMA method for each product.