


"I hereby declare that I have read this report and in my opinion this report is  
qualify to be awarded the Degree of Bachelor Mechanical Engineering  
(Design & Innovation)

Signature : .....  
Supervisor Name : Mohd. Rizal Bin Alkahari.  
Date : 8 MAY 2007.....

**DESIGN FOR MANUFACTURE AND ASSEMBLY (DFMA)  
EVALUATION OF CAR AUDIO FRONT PANEL**


**MELLYVNE SIGO**

**This report is submitted to the Faculty of Mechanical Engineering  
to fulfill the partial requirement for awarding the  
Degree of Bachelor Mechanical Engineering (Design & Innovation)**

**Faculty of Mechanical Engineering  
Universiti Teknikal Malaysia Melaka**

**8<sup>th</sup> May 2007**

“I hereby declare that this report is made by myself except for summary and statement that each of it I declared the sources”

Signature :  .....

Author Name : Mellvyne Sigo

Date : 8<sup>th</sup> May 2007

## ACKNOWLEDGEMENT

First of all I want to thank **JESUS**, My **LORD**, My **MASTER** and My **SAVIOR**, who has always loved me, helped, guided and protected me until I can finish my Projek Sarjana Muda (PSM) and this thesis. I would like to thank my Supervisor, Mr. Mohd. Rizal B. Alkahari for always monitor, guide and correct me along this PSM. I believe that this PSM and thesis can be done because of your effort to ensure that the objective of my project is achieved and successful. Beside that, thank you so much for the time that you have spend with my project along the PSM period.

Last but not least, my special thanks to Adriana Mathew and to all my family and friends for always encourage me and gave me a moral support. Thank you so much and I love you all! God bless u all...

## ABSTRACT

**Design for Manufacturing and Assembly (DFMA)** is a technique for reducing the cost of a product by breaking the product down into its simplest components. This paper is a detailed study which on the improvement of car audio front panel by using the DFMA approach. The Boothroyd-Dewhurst which concentrates on manual assembly methodology was used for the analysis of the existing product design in order to simplify and reduce the number of parts. Based on the assembly worksheet analysis of the current design, the number of parts for the current design is 25 parts with the number of operation assembly is 32. The time needed to complete assembly the current product is 146.12 seconds. Meanwhile, the assembly cost for the current product is 5.86 cents. As a result, the design efficiency for the current design is 20%. To ensure that the improvement of the current design is achieved, the analysis for the improved design must be made using the Boothroyd-Dewhurst method. Based on analysis done, it is found that the number of parts for the improved design can be reduced to 16 parts with the number of operation for the product assembly is reduced to 18. In order to assemble the current design, the time needed is 71.97 seconds. In the meantime, the assembly cost for the improved design is 2.89 cents. It is found that the design efficiency for the improved design is 67%. The comparison between assembly worksheet analysis for the current design and the improved design are also made to obtain the percentage of improvement. Therefore, the improvement in term of the number of parts is 36%, 50.7% improvement in assembly time, 50.7% improvement in assembly cost, 43.8% improvement in the number of operation and 70% improvement in design efficiency.

## ABSTRAK

**Rekabentuk untuk Pembuatan dan Pemasangan (DFMA)** adalah teknik untuk mengurangkan kos produk dengan mempermudah komponen-komponen yang terdapat di dalam produk tersebut. Teknologi “DFMA” ini boleh membawa kepada pengurangan jumlah komponen sehingga menjadikan produk tersebut mudah untuk dikendalikan dan dipasang semasa proses pemasangan produk. Tesis ini adalah kajian terperinci yang membahaskan tentang pembaikan ke atas panel hadapan audio kereta dengan menggunakan pendekatan “DFMA”. Sehubungan dengan itu, kaedah Boothroyd-Dewhurst yang lebih berfokus kepada pemasangan manual telah digunakan untuk mempermudah serta mengurangkan jumlah komponen produk yang sedia ada. Berdasarkan keputusan analisa lembaran kerja pemasangan bagi produk yang sedia ada, jumlah komponen yang terdapat pada produk tersebut adalah sebanyak 25 komponen dengan melibatkan sebanyak 32 operasi dalam pemasangan produk tersebut. Masa yang diperlukan untuk pemasangan produk pula adalah sebanyak 146.12 saat. Manakala bagi kos pemasangan produk adalah sebanyak 5.86 sen. Oleh yang sedemikian, kecekapan produk bagi produk yang sedia ada adalah sebanyak 20%. Bagi memastikan pembaikan terhadap produk yang sedia ada tercapai, analisa terhadap rekabentuk baru produk perlulah dilakukan dengan menggunakan kaedah Boothroyd-Dewhurst. Justeru itu, merujuk kepada analisa yang telah dibuat, didapati jumlah komponen bagi produk tersebut telah dikurangkan kepada 16 komponen dengan jumlah operasi yang terlibat ialah sebanyak 18 operasi. Masa pemasangan produk yang diperlukan pula adalah sebanyak 71.97 saat. Manakala bagi kos pemasangan produk adalah sebanyak 2.89 sen. Selain itu, didapati juga kecekapan produk bagi rekabentuk baru produk adalah sebanyak 67%. Perbandingan di antara rekabentuk lama dan rekabentuk baru produk juga dibuat bagi mendapatkan peratusan pembaikan. Justeru itu, peratusan pembaikan dari segi jumlah produk ialah 36%, masa pemasangan; 50.7%, kos pemasangan; 50.7%, jumlah operasi; 43.8%, dan kecekapan rekabentuk meningkat sebanyak 70%.

## CONTENTS

CHAPTER	ITEMS	PAGE
1	<b>INTRODUCTION</b>	<b>1</b>
	1.1 Objective	4
	1.2 Scopes	4
2	<b>LITERATURE REVIEW</b>	<b>5</b>
	2.1 Definition of DFMA	5
	2.1.1 Design For Manufacture (DFM)	6
	2.1.2 Design For Assembly (DFA)	9
	2.2 Methods of DFMA	16
	2.3 Effect of Implementing DFMA	21
	2.4 Example of Case Study on DFMA	25
	2.5 The Benefits of DFMA	31
3	<b>METHODOLOGY</b>	<b>32</b>
	3.1 Method Selection	32
	3.2 Procedures of Boothroyd-Dewhurst Method	33
4	<b>ANALYSIS &amp; DISCUSSIONS</b>	<b>42</b>
	4.1 Analysis of Car Audio Front Panel	42
	4.1.1 Mechanism of the product	42
	4.1.2 Function & critics of the existing product	51

4.1.3 Product structure tree of existing product	60
4.1.4 Plan layout of existing product	61
4.1.5 Assembly worksheet analysis of existing product	71
4.1.6 Result of the analysis for existing product	79
4.1.7 Assembly worksheet analysis of the existing product	80
4.2 Design Concept Selection of Improved Design	81
4.2.1 Design concept selection procedure for improved	82
4.3 Mechanism of Improved Design	87
4.4 Assembly Drawing of Improved Design	89
4.5 Product Structure Tree of Improved Design	90
4.6 Plan Layout of Improved Design	91
4.7 Process Flow Chart of Improved Design	99
4.8 Assembly Worksheet Analysis Improved of Design	100
4.9 Result of The Analysis for Improved Design	101
4.10 Material Requirement For Improved Design	101
4.10.1 Material selection	102
4.10.2 Selected material	103
4.10.3 Material costs	106
4.11 The Processes Selection	107
4.11.1 The processes selection of improved design procedure	111
4.11.2 Summary of processes selection	124
4.12 Comparison Between Old & Improved design	126
4.12.1 Percentage of part reduction	131
4.12.2 Percentage of assembly time reduction	131
4.12.3 Percentage of assembly cost	132



	4.12.4 Percentage of design efficiency	132
	4.12.5 Summary	133
5	<b>CONCLUSION</b>	134
6	<b>FURTHER RECOMMANDATION</b>	135
7	<b>REFERENCES</b>	136-137
	<b>APPENDIX</b>	138-162

## LIST OF TABLES

TABLE NO.	TITLE	PAGE
Table 2.1	Results of DFA Analysis for the Motor Drive Assembly Proposed Design	23
Table 2.2	Results of DFA Analysis for the Motor Drive Assembly Redesign	24
Table 2.3	Comparison of Parts Cost for the Proposed Design and Redesign	24
Table 3.1	Classification, coding and database for affecting manual handling time (sec).	35
Table 3.2	Classification, coding and database manual insertion and fastening (sec).	38
Table 3.3	Example of completed worksheet analysis for the controller assembly.	41
Table 4.1	Plan layout of Daytona MP26, front panel.	61
Table 4.2	No. of items, RP is 2 because PCBA involves two times operation	72
Table 4.3	First digit of the coding system is 3 when $(\alpha + \beta) = 720^\circ$ .	73
Table 4.4	Second digit of the coding system is 3 when PCBA has a size $>6$ mm and a thickness $\leq 2$ mm.	73
Table 4.5	The manual handling code, HC is 33.	74

<b>Table 4.6</b>	<b>Handling time is 2.51 seconds when the handling code, HC is 33.</b>	<b>74</b>
<b>Table 4.7</b>	<b>The part is in the Group II because it will secure immediately after the insertion.</b>	<b>75</b>
<b>Table 4.8</b>	<b>The first digit code is 3because it easily reaches to the desired location</b>	<b>75</b>
<b>Table 4.9</b>	<b>The manual insertion code, IC is 30.</b>	<b>76</b>
<b>Table 4.10</b>	<b>The insertion time per item (s) is 2 seconds when the manual insertion code, IC is 30.</b>	<b>77</b>
<b>Table 4.11</b>	<b>The total operation time is 9.02</b>	<b>78</b>
<b>Table 4.12</b>	<b>The total operation cost is 0.36 cents.</b>	<b>78</b>
<b>Table 4.13</b>	<b>The figure for minimum parts is 1</b>	<b>79</b>
<b>Table 4.14</b>	<b>Completed worksheet analysis of existing product</b>	<b>80</b>
<b>Table 4.15</b>	<b>Example of selection criteria</b>	<b>81</b>
<b>Table 4.16</b>	<b>Concept screening of button set</b>	<b>82</b>
<b>Table 4.17</b>	<b>Concept screening of volume rocker</b>	<b>83</b>
<b>Table 4.18</b>	<b>Concept screening of front cover</b>	<b>83</b>
<b>Table 4.19</b>	<b>Concept scoring of button set</b>	<b>84</b>
<b>Table 4.20</b>	<b>Concept scoring of volume rocker</b>	<b>85</b>
<b>Table 4.21</b>	<b>Concept scoring of front cover</b>	<b>85</b>
<b>Table 4.22</b>	<b>Morphological chart for concept selection</b>	<b>86</b>
<b>Table 4.23</b>	<b>Plan layout of improved design</b>	<b>91</b>
<b>Table 4.24</b>	<b>Completed worksheet analysis of improved design</b>	<b>100</b>
<b>Table 4.25</b>	<b>General recommendation for plastic product.</b>	<b>104</b>
<b>Table 4.26</b>	<b>The properties of thermoplastics</b>	<b>104</b>
<b>Table 4.27</b>	<b>Summary of the selected material</b>	<b>106</b>
<b>Table 4.28</b>	<b>Shape generation capabilities of processes.</b>	<b>109</b>

<b>Table 4.29</b>	<b>The compatibility between processes &amp; materials</b>	<b>110</b>
<b>Table 4.30</b>	<b>The processes selection base on the first four geometric (Preset Key)</b>	<b>112</b>
<b>Table 4.31</b>	<b>The Processes Selection Base on the further four geometric attributes (Preset Key)</b>	<b>113</b>
<b>Table 4.32</b>	<b>The process selection based on all shape attributes (Preset Key)</b>	<b>114</b>
<b>Table 4.33</b>	<b>The final process selection based on process combinations of the part (Preset Key)</b>	<b>115</b>
<b>Table 4.34</b>	<b>The processes selection base on the first four geometric (Volume Rocker)</b>	<b>116</b>
<b>Table 4.35</b>	<b>The Processes Selection Base on the further four geometric attributes (Volume Rocker)</b>	<b>117</b>
<b>Table 4.36</b>	<b>The process selection based on all shape attributes (Volume Rocker)</b>	<b>118</b>
<b>Table 4.37</b>	<b>The final process selection based on process combinations of the part (Volume Rocker)</b>	<b>119</b>
<b>Table 4.38</b>	<b>The processes selection base on the first four geometric (Front Cover)</b>	<b>120</b>
<b>Table 4.39</b>	<b>The Processes Selection Base on the further four geometric attributes (Front Cover)</b>	<b>121</b>
<b>Table 4.40</b>	<b>The process selection based on all shape attributes(Front Cover)</b>	<b>122</b>
<b>Table 4.41</b>	<b>The final process selection based on process combinations of the part (Front Cover)</b>	<b>123</b>
<b>Table 4.42</b>	<b>Summary of processes selection</b>	<b>124</b>
<b>Table 4.43</b>	<b>The comparative costs and production volumes for processing of plastics</b>	<b>125</b>

<b>Table 4.44</b>	<b>Economics production quantities for various molding methods.</b>	<b>125</b>
<b>Table 4.45</b>	<b>The summary of comparison between Old Design and Improved Design</b>	<b>133</b>

## LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
Figure 1.1	Traditional manufacturing process	1
Figure 2.1	Who casts the biggest shadow?	6
Figure 2.2	DFA Process	9
Figure 2.3	Geometrical features affecting part handling	10
Figure 2.4	Some other features affecting part handling	11
Figure 2.5	Incorrect geometry can allow part to jam during insertion	11
Figure 2.6	Provision of air-relief passages to improve insertion into blind holes	12
Figure 2.7	Design for ease of insertion	12
Figure 2.8	Provision of chamfers to allow easy insertion.	12
Figure 2.9	Standardize parts	13
Figure 2.10	Single-axis pyramid assembly.	13
Figure 2.11	Provision of self-locating features to avoid holding down and alignment	13
Figure 2.12	Design to aid insertion	14
Figure 2.13	Common fastening methods	14
Figure 2.14	Insertion from opposite directions requires repositioning of assembly.	15

<b>Figure 2.15</b>	<b>Common assembly automation device</b>	<b>17</b>
<b>Figure 2.16</b>	<b>Configuration of required motor drive assembly</b>	<b>19</b>
<b>Figure 2.17</b>	<b>Proposed design of motor drive assembly.</b>	<b>22</b>
<b>Figure 2.18</b>	<b>Redesign of motor drive assembly following design for assembly (DFA).</b>	<b>23</b>
<b>Figure 2.19</b>	<b>FASTRAC turbopump assembly</b>	<b>25</b>
<b>Figure 2.20</b>	<b>Automotive turbocharger dissembled</b>	<b>26</b>
<b>Figure 2.21</b>	<b>Oil Pump</b>	<b>27</b>
<b>Figure 2.22</b>	<b>Motor Coach</b>	<b>27</b>
<b>Figure 2.23</b>	<b>Existing Design</b>	<b>28</b>
<b>Figure 2.24</b>	<b>New Design</b>	<b>29</b>
<b>Figure 2.25</b>	<b>Original Design -- Total parts count = 39</b>	<b>30</b>
<b>Figure 2.26</b>	<b>Re-Design -- Total parts count = 9</b>	<b>30</b>
<b>Figure 3.1</b>	<b>The design details</b>	<b>33</b>
<b>Figure 3.2</b>	<b>The assembly apart</b>	<b>34</b>
<b>Figure 3.3</b>	<b>Alpha, <math>\alpha</math> and Beta, <math>\beta</math> rotational symmetries for various parts</b>	<b>37</b>
<b>Figure 4.1</b>	<b>The existing product of Daytona MP26, front panel</b>	<b>42</b>
<b>Figure 4.2</b>	<b>The components of Daytona MP26, front panel</b>	<b>43 - 48</b>
<b>Figure 4.3</b>	<b>Product assembly drawing</b>	<b>49</b>
<b>Figure 4.4</b>	<b>The assembly process flow of the Daytona MP26, front panel</b>	<b>50</b>
<b>Figure 4.5</b>	<b>PCBA</b>	<b>51</b>
<b>Figure 4.6</b>	<b>Light guide group</b>	<b>51</b>
<b>Figure 4.7</b>	<b>Diffuser foil</b>	<b>52</b>
<b>Figure 4.8</b>	<b>Zebra connector</b>	<b>52</b>
<b>Figure 4.9</b>	<b>LCD</b>	<b>52</b>

<b>Figure 4.10</b>	<b>Screen plate</b>	<b>53</b>
<b>Figure 4.11</b>	<b>Keypad</b>	<b>53</b>
<b>Figure 4.12</b>	<b>On / Off button</b>	<b>53</b>
<b>Figure 4.13</b>	<b>Front cover</b>	<b>54</b>
<b>Figure 4.14</b>	<b>Button Set: BND.TS</b>	<b>54</b>
<b>Figure 4.15</b>	<b>Button Set: 1</b>	<b>54</b>
<b>Figure 4.16</b>	<b>Button Set: 2</b>	<b>55</b>
<b>Figure 4.17</b>	<b>Button Set: 3</b>	<b>55</b>
<b>Figure 4.18</b>	<b>Button Set: 4</b>	<b>55</b>
<b>Figure 4.19</b>	<b>Button Set: 5</b>	<b>56</b>
<b>Figure 4.20</b>	<b>Button Set: 6</b>	<b>56</b>
<b>Figure 4.21</b>	<b>Button Set: X-BASS</b>	<b>56</b>
<b>Figure 4.22</b>	<b>Volume rocker</b>	<b>57</b>
<b>Figure 4.23</b>	<b>Soft memory key</b>	<b>57</b>
<b>Figure 4.24</b>	<b>4-Way key</b>	<b>57</b>
<b>Figure 4.25</b>	<b>Compression spring</b>	<b>58</b>
<b>Figure 4.26</b>	<b>Release button</b>	<b>58</b>
<b>Figure 4.27</b>	<b>Eject button</b>	<b>58</b>
<b>Figure 4.28</b>	<b>Back cover</b>	<b>59</b>
<b>Figure 4.29</b>	<b>Thread screw</b>	<b>59</b>
<b>Figure 4.30</b>	<b>Product structure tree of existing product</b>	<b>60</b>
<b>Figure 4.31</b>	<b>LCD assembly</b>	<b>62</b>
<b>Figure 4.32</b>	<b>Equipment for LCD assembly</b>	<b>62</b>
<b>Figure 4.33</b>	<b>Clinching assembly</b>	<b>63</b>
<b>Figure 4.34</b>	<b>Clinching jig</b>	<b>63</b>
<b>Figure 4.35</b>	<b>On/Off button assembly</b>	<b>64</b>
<b>Figure 4.36</b>	<b>Equipment of on/off button assembly</b>	<b>64</b>
<b>Figure 4.37</b>	<b>LCD Module to Front Cover Assembly</b>	<b>65</b>



<b>Figure 4.10</b>	<b>Screen plate</b>	<b>53</b>
<b>Figure 4.11</b>	<b>Keypad</b>	<b>53</b>
<b>Figure 4.12</b>	<b>On / Off button</b>	<b>53</b>
<b>Figure 4.13</b>	<b>Front cover</b>	<b>54</b>
<b>Figure 4.14</b>	<b>Button Set: BND.TS</b>	<b>54</b>
<b>Figure 4.15</b>	<b>Button Set: 1</b>	<b>54</b>
<b>Figure 4.16</b>	<b>Button Set: 2</b>	<b>55</b>
<b>Figure 4.17</b>	<b>Button Set: 3</b>	<b>55</b>
<b>Figure 4.18</b>	<b>Button Set: 4</b>	<b>55</b>
<b>Figure 4.19</b>	<b>Button Set: 5</b>	<b>56</b>
<b>Figure 4.20</b>	<b>Button Set: 6</b>	<b>56</b>
<b>Figure 4.21</b>	<b>Button Set: X-BASS</b>	<b>56</b>
<b>Figure 4.22</b>	<b>Volume rocker</b>	<b>57</b>
<b>Figure 4.23</b>	<b>Soft memory key</b>	<b>57</b>
<b>Figure 4.24</b>	<b>4-Way key</b>	<b>57</b>
<b>Figure 4.25</b>	<b>Compression spring</b>	<b>58</b>
<b>Figure 4.26</b>	<b>Release button</b>	<b>58</b>
<b>Figure 4.27</b>	<b>Eject button</b>	<b>58</b>
<b>Figure 4.28</b>	<b>Back cover</b>	<b>59</b>
<b>Figure 4.29</b>	<b>Thread screw</b>	<b>59</b>
<b>Figure 4.30</b>	<b>Product structure tree of existing product</b>	<b>60</b>
<b>Figure 4.31</b>	<b>LCD assembly</b>	<b>62</b>
<b>Figure 4.32</b>	<b>Equipment for LCD assembly</b>	<b>62</b>
<b>Figure 4.33</b>	<b>Clinching assembly</b>	<b>63</b>
<b>Figure 4.34</b>	<b>Clinching jig</b>	<b>63</b>
<b>Figure 4.35</b>	<b>On/Off button assembly</b>	<b>64</b>
<b>Figure 4.36</b>	<b>Equipment of on/off button assembly</b>	<b>64</b>
<b>Figure 4.37</b>	<b>LCD Module to Front Cover Assembly</b>	<b>65</b>

<b>Figure 4.65</b>	<b>Visual Inspection Machine</b>	<b>97</b>
<b>Figure 4.66</b>	<b>Equipment for FQC</b>	<b>98</b>
<b>Figure 4.67</b>	<b>Station 10 for packaging</b>	<b>98</b>
<b>Figure 4.68</b>	<b>The assembly process flow of the improved design</b>	<b>99</b>
<b>Figure 4.69</b>	<b>Sequence of different processes of part attributes</b>	<b>107</b>
<b>Figure 4.70</b>	<b>Comparison of main body before and after improvement</b>	<b>126</b>
<b>Figure 4.71</b>	<b>Comparison of preset key before and after improvement.</b>	<b>127</b>
<b>Figure 4.72</b>	<b>Comparison of volume rocker before and after improvement.</b>	<b>128</b>
<b>Figure 4.73</b>	<b>Comparison of front cover before and after improvement.</b>	<b>129</b>
<b>Figure 4.74</b>	<b>Comparison of plant layout before and after improvement</b>	<b>130</b>

## LISTS OF APPENDIX

APPENDIX	TITLE	PAGE
<b>A</b>	<b>Motor Drive: (a) Current Design</b>	<b>138</b>
<b>B</b>	<b>Motor Drive: (b) Re-Design</b>	<b>139</b>
<b>C</b>	<b>Grating Arm Assembly (Current Design)</b>	<b>140</b>
<b>D</b>	<b>Grating Arm Assembly (Re-Design)</b>	<b>141</b>
<b>E</b>	<b>The Assembly Process Flow of the Daytona MP26, Front Panel</b>	<b>142</b>
<b>F</b>	<b>The Assembly Process Flow of Improved Design</b>	<b>143</b>
<b>G</b>	<b>Cost of Thermoplastic Polymers</b>	<b>144</b>
<b>H</b>	<b>Front Cover</b>	<b>145</b>
<b>I</b>	<b>Back Cover</b>	<b>146</b>
<b>J</b>	<b>Soft Memory Key</b>	<b>147</b>
<b>K</b>	<b>Volume Rocker</b>	<b>148</b>
<b>L</b>	<b>On/Off Button</b>	<b>149</b>
<b>M</b>	<b>Keypad</b>	<b>150</b>
<b>N</b>	<b>Eject Key</b>	<b>151</b>
<b>O</b>	<b>Release Button</b>	<b>152</b>
<b>P</b>	<b>Compression Spring</b>	<b>153</b>
<b>Q</b>	<b>Preset Key</b>	<b>154</b>
<b>R</b>	<b>LCD Screen</b>	<b>155</b>
<b>S</b>	<b>Screen Plate</b>	<b>156</b>

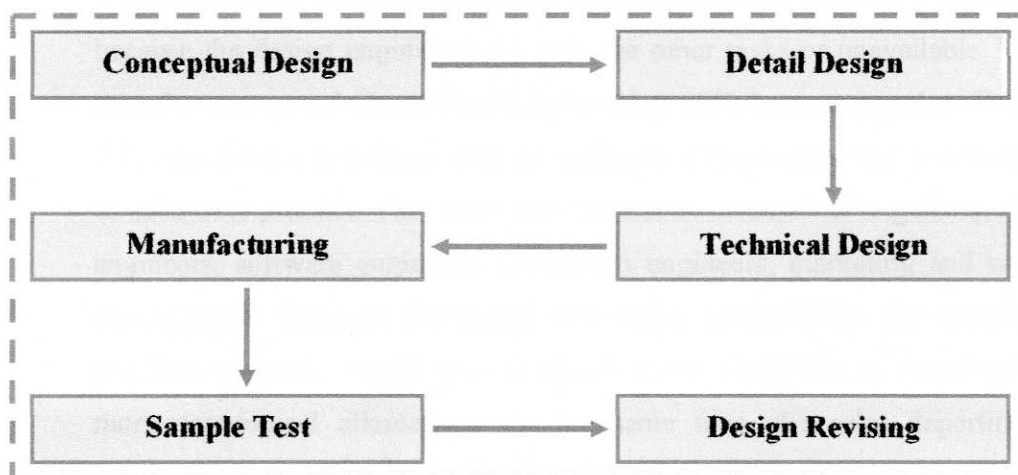
<b>T</b>	<b>Zebra Connector</b>	<b>157</b>
<b>U</b>	<b>Light Guide</b>	<b>158</b>
<b>V</b>	<b>Diffuser Foil</b>	<b>159</b>
<b>W</b>	<b>PCBA</b>	<b>160</b>
<b>X</b>	<b>Assembly Drawing</b>	<b>161</b>
<b>Y</b>	<b>Exploded Drawing</b>	<b>162</b>

## CHAPTER 1

### INTRODUCTION

The history of Design for Manufacturing and Assembly (DFMA) actually begins before the Second World War. Ford and Chrysler was used the DFM philosophy to design and manufacture their weapons, tanks and other military products.

The early and significant work on DFM and DFA are mostly begins in the early 1970s. The first persons that make the research job in this technology are Dr. Geoffrey Boothroyd and Dr. Peter Dewhurst, until in 1982 they were founded the Boothroyd Dewhurst, Inc. (BDI). (Xiaofan Xie. 2006). They created and developed the DFMA concept and use it in developing the products of their company such as the DFMA software system. Meanwhile, their company was trademark by the “DFMA”.



*Figure 1.1: Traditional manufacturing process. (Xiaofan Xie. 2006).*

Figure 1.1 shows the traditional manufacturing process. The design engineers will create the detail drawing while assembly engineer create the assembly plan base on the conceptual design of the parts. After the detail drawing and the assembly plan was created, the prototype will be produced then make a sample test on it. According to the sample test the workshop then gives a feedback to the design engineers and assembly engineer about the prototype and the result of the sample test. The design engineers and assembly engineers will use that information to redesign the product, the assembly plan and the manufacturing process. The same cycle repeats again and again until arriving at competitive design.

However, there are two things were changes in 1970's (*Otto. and Wood. 2006*):-

- i) Many new types of plastics were developed, and injection molding technology became widely used because the possibility of low cost plastic components. Beside that the plastic materials also provided different material behavior. For example, many cycles of large elastic deformations without failure are a property useful in making snap-fit mating components. Thus parts that had to be made form metal and screwed together could just be made out of plastic and snap fitted.
- ii) Several companies try to bring their products to the market faster. However, when each time there was a design change made by the manufacturing engineer; product development will hold up and waiting for the Engineering Change Notice (ECN) to be approved by the designer. Often, this process will be delays because the design engineer busy with the other tasks or unavailable. To avoid this, the concept of **Concurrent Engineering (CE)** became popular. The idea of this concept is a combined team of engineers and management will be assigned to each new product. This team may consist of mechanical engineers, electrical engineers, software engineers, production engineers, marketing and sales, and management. Thus, as the design was being generated by the designers, the production people would give feedback about feasibility to manufacture and more economical alternatives. At the same time, the sales department will negotiate about the product outlook and features, and so on.

Nowadays, DFMA is widely used in almost all industrial fields especially in the product design and development. It is commonly used to make an improvement in the design of the existing product including printed circuit boards, manual assembly, robotic assembly, and machining. Beside that, most of the companies today realize that the DFMA methodology is very important in manufacturing and assembly because it can give a big impact in the product design efficiency, the number of parts, time of product assembly, and cost to manufacture the product.

The main goal of DFMA is to lower product cost by examining the product design and structure at the early concept stages of a new product. At the same time, the design engineers also have to consider all of the factors that affect the final outputs as early as possible in the design cycle. The extra time spent in the early design stage is much less the time that will be spent in the repeatedly redesign. DFMA also leads to improvements in serviceability, reliability, and quality of the end product. It minimizes the total product cost by targeting assembly time, part cost, and the assembly process in the early stages of the product development cycle. Beside that, DFMA allows for improved supply chain cost management, product quality and manufacturing, and communication between Design, Manufacturing, Purchasing and Management. The life of a product begins with defining a set of product needs, which are then translated into a set of product concepts. Design engineer will takes these product concepts and refines them into a detailed product design. To be truly successful, the DFMA process should start at the early concept development phase of the project. True, it will take time during the hectic design phase to apply DFMA, but the benefits easily justify additional time.

Therefore this project is a highly regard as fully related to the DFMA and has been developed based on DFMA methodology. The title of this project is *Design for Manufacture and Assembly (DFMA), Evaluation of Car Audio Front Panel*.

## **1.1 Objective**

The main objective of this project is to improve the design of the car audio front panel in term of the product design efficiency, the number of parts, the product assembly time, and manufacturing cost of the product. In order to make the improvement, the DFMA approach is applied to analyze the existing product.

## **1.2 Scopes**

The scopes of this project are set at early stage of the project to ensure that the objective of the project can be achieved. The scopes for this project are:-

- i. Study the concept and methods of DFMA.
- ii. Analyze the methods of manufacturing and assembly of the existing product.
- iii. Improve the car audio front panel design by using the DFMA methodology analysis.
- iv. To propose a new design based on analysis made.