WORK IMPROVEMENT AT AN ENGINE ASSEMBLY LINE AT CAR MANUFACTURING PLANT

Fadzilah binti Adnan

Universiti Teknologi Malaysia
WORK IMPROVEMENT AT AN ENGINE ASSEMBLY LINE AT CAR MANUFACTURING PLANT

Fadzilah binti Adnan

A Project Report submitted in fulfilment of the requirement for the award of the degree of Master of Engineering (Industrial Engineering)

Faculty of Mechanical Engineering
Universiti Teknologi Malaysia

DECEMBER 2010
Specially dedicated to my beloved parents, siblings, and friends
who have always been supportive
ACKNOWLEDGEMENT

First and for most, I would like to express my deepest thank to Allah the Almighty for His guidance and help in giving me the strength to complete this project. My utmost gratitude goes to my supervisor, Assc. Prof. Dr. Abd. Rahman bin Abdul Rahim for his constructive advice, continuous guidance and encouragement throughout the period of this project.

I would also like to express my special thank to En Syuhada, En Suharto, supervisors at ETM engine assembly line and En. Muhammad Firdaus, engineer at ETM engine assembly line for their willingness to assist me in conducting this project at this company from the very beginning up until the end.

Gratitude and appreciation is also expressed to other individuals who have been very supportive during the completion of this project. Last but not least, appreciation is extended to my beloved parents, Aisyah binti Abdul Samad and Adnan bin Jaafar for their continuous encouragement and care. Their support and understanding had always becomes my prime motivation in completing this project.
ABSTRACT

The project was carried out at ETM engine assembly line at a car assembly plant. The objectives of this project are to reduce cycle time in ETM assembly at EA21 workstation and suggest improvement technique to overcome the problem. The company produces many types of engines and the process of producing one engine has been chosen for this project. The study only focus on the internal part of engine assembly line. By assuming all work is normally distributed, time study is done using continuous stop watch method in order to determine the standard time of all the processes involved. Data collection was done through observations, interviews, and study of company records and discussion with supervisors and engineer. Pareto Chart is constructed to determine problem which lead to the high waste operation time. Poor Line balancing is the main problem with 330 hours or 67.1% time lost. Simulation using WITNESS software and line balancing analysis has been chosen to overcome the problem. Through these techniques, 4 alternative models have been developed. Alternative 3 proposed using color coding for parts storage rack has been selected as the best alternative. The scoring was done by taking three performance measurements into account which is cycle time, line balancing loss, and cost.
ABSTRAK

# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECLARATION</td>
<td>ii</td>
<td></td>
</tr>
<tr>
<td>DEDICATION</td>
<td>iii</td>
<td></td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td>iv</td>
<td></td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>v</td>
<td></td>
</tr>
<tr>
<td>ABSTRAK</td>
<td>vi</td>
<td></td>
</tr>
<tr>
<td>TABLE OF CONTENT</td>
<td>vii</td>
<td></td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xii</td>
<td></td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xiv</td>
<td></td>
</tr>
<tr>
<td>LIST OF APPENDICES</td>
<td>xxi</td>
<td></td>
</tr>
</tbody>
</table>

1 INTRODUCTION 1

1.1 Introduction 1

1.2 Background of the Project 2

1.3 Objectives of Project 2

1.4 Scope of Project 2

1.5 Methodology 3

1.6 Summary 3

2 LITERATURE REVIEW 4

2.1 Introduction 4

2.2 Productivity 4

2.3 Time Study 6
2.4 Line Balancing
  2.4.1 Classification of Line Balancing
  2.4.2 Line Balancing Algorithm
2.5 Simulation
  2.5.1 Witness Simulation Software
2.6 Summary

3 METHODOLOGY
  3.1 Introduction
  3.2 Research Procedure
  3.3 Observation
  3.4 Interview with Engineer and Supervisor
  3.5 Study Company’s Documentation
  3.6 Conclusion

4 DATA COLLECTION AND ANALYSIS
  4.1 Introduction
  4.2 Case Study
  4.3 Company Profile
  4.4 Engine Types
  4.5 Production Capacity
  4.6 Location and Layout
  4.7 Product Description
  4.8 EA21 Assembly Line
  4.9 Identified Problems
    4.9.1 Glare at Monitor Display
    4.9.2 Poor Layout Design
    4.9.3 Inventory Problems
    4.9.5 Quality Issues
  4.10 Problem Selection
  4.11 Summary
MODELLING THE CURRENT SYSTEM  

5.1 Preliminary Data Analysis  

5.2 Simulation Modelling Observation  

5.3 Process Flow of Simulation Project  
   5.3.1 Simulation Objective  
   5.3.2 Data Collection  
   5.3.3 Model Building and Testing  

5.4 Summary  

PROPOSED ALTERNATIVE SOLUTION  

6.1 Main Problem with the Current System  

6.2 Building Alternative Solution  
   6.2.1 Add a Machine to Assemble Wheel and Bearing  
   6.2.2 Rack Using Color Coding  
   6.2.3 Adding Automation Information Display  
   6.2.4 Add Inspection Workstation  

6.3 Comparison of Cycle Time Among Alternatives  

6.4 Cost Analysis  
   6.4.1 Direct Cost Labor  
   6.4.2 Additional Machine Cost  

6.5 Line Balancing Loss  

6.6 Selecting Best Alternative  

6.7 Summary  

CONCLUSION AND SUGGESTION  

7.1 Conclusion  

7.2 Suggestion for Future Work  

REFERENCES  

APPENDICES
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE NO</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 4.1</td>
<td>Process flow chart for oil pan assembly</td>
<td>31</td>
</tr>
<tr>
<td>Table 4.2</td>
<td>Normal and standard time calculation</td>
<td>36</td>
</tr>
<tr>
<td>Table 4.3</td>
<td>Total time loss factors</td>
<td>41</td>
</tr>
<tr>
<td>Table 5.1</td>
<td>Controllable and uncontrollable variable</td>
<td>45</td>
</tr>
<tr>
<td>Table 5.2</td>
<td>Definition for element in current system simulation model</td>
<td>48</td>
</tr>
<tr>
<td>Table 6.1</td>
<td>Total time required vs model</td>
<td>51</td>
</tr>
<tr>
<td>Table 6.2</td>
<td>Current system with inspection workstation</td>
<td>55</td>
</tr>
<tr>
<td>Table 6.3</td>
<td>Total production time vs alternatives</td>
<td>57</td>
</tr>
<tr>
<td>Table 6.4</td>
<td>Total cost and additional cost of every alternative</td>
<td>59</td>
</tr>
<tr>
<td>Table 6.5</td>
<td>Line balancing vs alternative</td>
<td>60</td>
</tr>
<tr>
<td>Table 6.7</td>
<td>Final score for each alternative</td>
<td>64</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE NO</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 3.1</td>
<td>Methodology for project1</td>
<td>17</td>
</tr>
<tr>
<td>Figure 3.2</td>
<td>Methodology for project2</td>
<td>18</td>
</tr>
<tr>
<td>Figure 4.1</td>
<td>Basic parts for engine assembly</td>
<td>23</td>
</tr>
<tr>
<td>Figure 4.2</td>
<td>ETM plant layout</td>
<td>24</td>
</tr>
<tr>
<td>Figure 4.3</td>
<td>Plant layouts EA21</td>
<td>25</td>
</tr>
<tr>
<td>Figure 4.4</td>
<td>Campro engine at ETM production line</td>
<td>25</td>
</tr>
<tr>
<td>Figure 4.5</td>
<td>Flow chart process in EA21 production line</td>
<td>27</td>
</tr>
<tr>
<td>Figure 4.6</td>
<td>Picture of process in EA21 production line</td>
<td>28</td>
</tr>
<tr>
<td>Figure 4.7</td>
<td>Glare at loading block workstation</td>
<td>29</td>
</tr>
<tr>
<td>Figure 4.8</td>
<td>Cause and effect of glare</td>
<td>30</td>
</tr>
<tr>
<td>Figure 4.9</td>
<td>Workstation showing movement</td>
<td>30</td>
</tr>
<tr>
<td>Figure 4.10</td>
<td>Distance of worker movement</td>
<td>31</td>
</tr>
<tr>
<td>Figure 4.11</td>
<td>Pie chart of total travel distance lost per total working hour</td>
<td>33</td>
</tr>
<tr>
<td>Figure 4.12</td>
<td>Cause and effect diagram at oil pan assembly</td>
<td>33</td>
</tr>
<tr>
<td>Figure 4.13</td>
<td>Poor line balancing at connecting rod bearing workstation</td>
<td>35</td>
</tr>
<tr>
<td>Figure 4.14</td>
<td>Line balancing at EA21</td>
<td>36</td>
</tr>
<tr>
<td>Figure 4.15</td>
<td>Workstation activity and standard time for each workstation</td>
<td>37</td>
</tr>
<tr>
<td>Figure 4.16</td>
<td>Types of rejects</td>
<td>39</td>
</tr>
<tr>
<td>Figure 4.17</td>
<td>Types of reject occur at spark plug</td>
<td>39</td>
</tr>
<tr>
<td>Figure 4.18</td>
<td>Workstation activity and standard time for each workstation</td>
<td>40</td>
</tr>
</tbody>
</table>
Figure 4.19  Time loss factor vs time lost  41
Figure 5.1  The costs involve in engine production  43
Figure 5.2  Influence diagram  46
Figure 6.1  Current workstation  51
Figure 6.2  Suggestion of add machine to assemble
    wheel and bearing  52
Figure 6.3  Result of total cycle time for solution 1  52
Figure 6.4  Current workstation  53
Figure 6.5  Improve searching time at wheel station by re-design rack using
    color coding  54
Figure 6.6  Improve searching time at wheel station  54
Figure 6.7  Current workstation  55
Figure 6.8  Implementation adding automation information display  54
Figure 6.9  Adding automated information display  54
Figure 6.10  Current system without inspection workstation  55
Figure 6.11  Workstation with inspection  56
Figure 6.12  Current system with inspection workstation  56
Figure 6.13  Total production time vs alternatives  57
Figure 6.14  Total cost of every alternative  60
Figure 6.15  Improvement of line balancing vs alternative  61
Figure 6.16  Final score for each alternative  62
# LIST OF APPENDICES

<table>
<thead>
<tr>
<th>APPENDIX NO.</th>
<th>TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendix A</td>
<td>Gantt chart for project 1 and project 2</td>
</tr>
<tr>
<td>Appendix B</td>
<td>Standard time for engine process assembly line</td>
</tr>
<tr>
<td>Appendix C</td>
<td>Simulation of proposed solution</td>
</tr>
<tr>
<td>Appendix D</td>
<td>Presentation slide</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter discusses the background, objective, scope, and methodology of the project and organization of the report.

1.2 Background of the Project

This project seeks to improve productivity of an engine assembly line by applying method study, line balancing and time study. Markets pressure requires every manufacturing company to be able to respond quickly to variations in quantity and mix of produced goods.

Car manufacturing industries are growing rapidly in this country. Automotive manufacturers need to improve as well as quality, cost and delivery. Quality directly affects warranty costs and customer satisfaction. Productivity improvement requires knowledge of manufacturing processes.
1.3 Objectives of Project

This project is about work improvement in an automotive engine assembly line. The objectives of project are to:

a) Identify problems of ETM assembly at EA21 workstation
b) Suggest improvement to overcome the problem

1.4 Scope of Project

The scopes of the project are:

a) Only focused at EA21 engine assembly line
b) Cover work improvement only
c) All suggestion are not necessarily implemented

1.5 Methodology

This project is carried out using methodology. An engine assembly line at a car manufacturing plant is selected as case study. Observation of the manufacturing process is done to identify the main problem. Relevant data were collected through interviews with engineer and supervisor as well as using time study to determine cycle time for each operation.

Once the problems are determined, further data collections are carried out. A simulation model of the operation under study is then developed using gathered data.
By comparing the time from simulation process and actual process time, any variation can be observed. Alternative solutions can be generated followed by evaluation of each proposed solution. The alternative which provide the lowest throughput time will be chosen.

Conclusion and suggestion of future work will be included at the end of the project report. Gantt chart for this project is shown in Appendix A.

1.6 Summary

This chapter explains the background of the project, objectives and scope. The methodology to be applied in the project and problem solving method is also described.
REFERENCES


