QUALITY IMPROVEMENT BY USING TAGUCHI METHOD
IN DISK MANUFACTURING

MOHD HAFIZ BIN MOHAMMAD NOOR

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
QUALITY IMPROVEMENT BY USING TAGUCHI METHOD IN DISK MANUFACTURING

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Management) with Honours.

By

MOHD HAFIZ B. MOHAMMAD NOOR

FACULTY OF MANUFACTURING ENGINEERING
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PSM

JUDUL: QUALITY IMPROVEMENT BY USING TAGUCHI METHOD IN DISK MANUFACTURING

SESI PENGAJIAN: 2/2008-2009

Saya MOHD HAFIZ BIN MOHAMAD NOOR

mengaku membenarkan tesis (PSM/Sarjana/Doktor Falsafah) 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 berd arah keselamatan atau kepentingan Malaysia yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐ TERHAD  (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penulis dikenakan dijatuhkan)
☐ TIDAK TERHAD

(TANDATANGAN PENULIS)  

Alamat Tetap:
No.17, Kedai Batu Gajah, 17510 Tanah Merah, Kelantan.

Tarikh: 20/05/09

(TANDATANGAN PENYELIA)  

Cop Rasmi:
AB RAHMAN BIN MAHMOOD
Persiarah Kanan
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka

Tarikh: 26/05/09

* Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak bersangkutan/organisasi berkewajiban dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikecualikan sebagai SULIT atau TERHAD.
APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UiTM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Management). The members of the supervisory committee are as follow:

Abdul Rahman Bin Mahmood
(PSM Supervisor)

[Signature]

Rahman bin Mahmood
Penyelidik Kajian
Fakulti Kajian dan Pembinaan
Universiti Teknikal Malaysia Melaka
DECLARATION

I hereby declare that this report entitled “Software Development of in-line Quality Control in Small and Medium (SMII) Manufacturing Company” is the result of my own research except as cited in the references.

Signature: [Signature]
Author’s Name: Mohd Hafiz Bin Mohamad Noor
Date: 20th May 2009
ABSTRACT

“Quality improvement by using Taguchi Method in Disk Manufacturing” is the title of this project. This project was implemented to employ the Taguchi Method approach in the disk manufacturing, where an actual production shop-floor performance will be analyzed through Taguchi Method and as a result, alternative solution will be proposed in order to improve the product quality, efficiency and to enhance the performance of the manufacturing system. The company that has been chosen is Ohara Disk Malaysia Sdn. Bhd (ODM), located at Merlimau Industrial Zone, Melaka. The scope of this project focused on the section which Awa (bubble in disc) reject rate in the production shop floor. In conducting this project, a methodology based on the Taguchi design was used for achieving the objective. In the planned project flow chart, factory visit was carried out for observing the production system. From the visit, some necessary data regarding the production flow of whole system was collected. The data collected from the previous studies in the same company together with the one from textbooks, journals, and internet was use as additional input into the newly collected data from the latest visit to the company. Based on all the data collected, the experiment was conducted using the Orthogonal Array design to find optimum solution of the problem. The analysis was done to find the best combination of parameters and factors in order to achieve the research objectives.
ABSTRAK

DEDICATION

For my beloved dad, mom, family and my beloved friend
ACKNOWLEDGEMENT

In name of Allah S.W.T the most Merciful and the most Beneficent. First of all, thank to ALLAH SWT for His blessings and for deepest senses gratitude of the almighty that fives strength and ability to complete this thesis. I would like to extend my heartfelt gratitude to all that have been contributed to the success of this thesis.

First and foremost I would like to thank Mr. Hj. Abdul Rahman Bin Mahmood, the lecturer and supervisor for my thesis project, and I would like also to thank Mr Nor Akramin Bin Mohamad for their patience, cooperation’s and all the commitment in the performance of my research thesis.

Last but not least, I would like to thank to all my friend in helping me finish this thesis and not forget is to Mrs. Flora Chang, Ohara Disk (M) Sdn. Bhd. Human Resource Manager for giving me an opportunity to conduct my thesis at his company.

I sincerely hope that this thesis will prove to be very useful in efficiently utilizing my study. I believe that I able to realize it, Insyaallah.

Thank you.
TABLE OF CONTENT

Abstract i
Abstrak ii
Dedication iii
Acknowledgment iv
Table of Content v
List of Figures ix
List of Tables xi
List of Abbreviations and symbol xiii

1.0 INTRODUCTION 1
1.1. Background 1
1.2. Problem Statement 3
1.3. Objective 3
1.4. Importance of the project 3
1.5. Scope and Limitation 4
1.6. Organization of the Thesis 4

2.0 LITERATURE REVIEW 6
2.1. Introduction 6
2.2. Definition of Quality 7
2.3. Types of Quality 10
  2.3.1.1. Quality of Design 10
  2.3.1.2. Quality of Conformance 10
  2.3.1.3. Quality of Performance 11
2.4. Quality Dimensions 11
2.5. Quality Improvement 12
2.6. Introductions of Taguchi Method 14
### 4.2. Company Background

4.3. Company Organization Chart

4.4. Product

4.5. Company Method use for solving problem

4.5.1. Advantages of Fishbone Diagram

4.5.2. Disadvantages of Fishbone Diagram

4.6. Taguchi Method Implementations

4.6.1. Problem Recognition, Formulation and Organization of the Team

4.6.2. Selection of Quality Characteristic and Measurement System

4.6.3. Selection of the Design or Process Parameters that may Influences Quality Characteristic

4.6.4. Classification of Design or Process Parameters into Control, Noise and Signal Factors

4.6.5. Determination Number of Levels for Design or Process Parameters

4.6.6. Determination of the Interaction to be studied

4.6.7. Choice of Appropriate Orthogonal Arrays and Assignment of Design or Process Parameters and Interactions

4.6.8. Conducting the Experiment and Recording the Results

4.6.9. Analyzing the Experimental Data and Interpreting the Results

4.6.10. Confirmation Runs or Experiments (or follow up experiment)

### 5.0 PROCESS DEVELOPMENT

5.1. Introduction

5.2. Construct Taguchi Table (Orthogonal Array)

5.3. Design Specifications

5.4. Taguchi Orthogonal Array Design

5.5. Define Custom Taguchi Design

5.6. Analyze Taguchi Design

5.6.1. Generate plots of main effects

5.6.2. Interaction plots
6.0 RESULT & ANALYSIS… 77
6.1. Introduction 77
6.2. Designing the Experiments 78
6.2.1. Identify controllable factor 78
6.2.2. Selecting the Right OA (Orthogonal Array) 81
6.3. Analysis the Result 83
6.3.1. Computations of Average Performance 83
6.3.2. Statistical Analysis and Interpretation of Results 86
6.3.3. Main Effect plots 86
6.3.4 Interaction Plots 90
6.4. Quality Characteristics (Result) 93

7.0 CONCLUSION & RECOMMENDATION 96
7.1. Conclusion 96
7.2. Recommendation 97

REFERENCES 98
APPENDIX 102
<table>
<thead>
<tr>
<th>Number of Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>The Dimension of Quality</td>
<td>11</td>
</tr>
<tr>
<td>2.2</td>
<td>Table of Taguchi Designs (Orthogonal Arrays)</td>
<td>25</td>
</tr>
<tr>
<td>6.1</td>
<td>Controllable factors</td>
<td>79</td>
</tr>
<tr>
<td>6.2</td>
<td>L8 with test Data of Awa Process Experiment</td>
<td>82</td>
</tr>
<tr>
<td>6.3</td>
<td>Main Effects</td>
<td>85</td>
</tr>
<tr>
<td>6.4</td>
<td>ANOVA Table</td>
<td>85</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Number of Figure</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>The flow of the Taguchi develop (Robust Technology Development)</td>
<td>15</td>
</tr>
<tr>
<td>2.2</td>
<td>Total cost of quality U graph</td>
<td>22</td>
</tr>
<tr>
<td>2.3</td>
<td>P-diagram</td>
<td>24</td>
</tr>
<tr>
<td>3.1</td>
<td>Flow Chart of Methodology</td>
<td>36</td>
</tr>
<tr>
<td>3.2</td>
<td>Process Flow of Experiment Design</td>
<td>40</td>
</tr>
<tr>
<td>3.3</td>
<td>Process flow in Ohara Disk (M) Sdn. Bhd</td>
<td>41</td>
</tr>
<tr>
<td>4.1</td>
<td>Company logo</td>
<td>42</td>
</tr>
<tr>
<td>4.2</td>
<td>Organization Chart</td>
<td>44</td>
</tr>
<tr>
<td>4.3</td>
<td>Ohara Disk Product, Blank Disk for Hard Disk Drive</td>
<td>45</td>
</tr>
<tr>
<td>4.4</td>
<td>Fish bone Diagram</td>
<td>47</td>
</tr>
<tr>
<td>5.1</td>
<td>Minitab Worksheet</td>
<td>60</td>
</tr>
<tr>
<td>5.2</td>
<td>Create Taguchi Design</td>
<td>60</td>
</tr>
<tr>
<td>5.3</td>
<td>Taguchi Design setting</td>
<td>61</td>
</tr>
<tr>
<td>5.4</td>
<td>Taguchi Design – Available Design</td>
<td>62</td>
</tr>
<tr>
<td>5.5</td>
<td>Taguchi Design – Design</td>
<td>63</td>
</tr>
<tr>
<td>5.6</td>
<td>Taguchi Design – Factors</td>
<td>63</td>
</tr>
</tbody>
</table>
5.7 Taguchi Design – Options 64
5.8 Start the Taguchi Design 64
5.9 Orthogonal Array Table 65
5.10 Inserting the Quantity Rejects Result 66
5.11 Define Custom Taguchi Design 67
5.12 Define the factors of Custom Taguchi Design 67
5.13 Select the factors of Custom Taguchi Design 68
5.14 Analyze Taguchi Design 70
5.15 Analyze Taguchi Design - Graph 70
5.16 Analyze Taguchi Design – Analysis 71
5.17 Analyze Taguchi Design – Terms 71
5.18 Analyze Taguchi Design – Analysis Graph 72
5.19 Analyze Taguchi Design - Options 72
5.20 Analyze Taguchi Design - Storage 73
5.21 Main Effect plot for means 74
5.22 Main Effect plot for SN ratios 74
5.23 Interaction plot for Means 75
5.24 Interaction plot for SN ratios 76

6.1 Experiment Structure 80
6.2 Trial Runs and Conditions 80
6.3 Main Effect 87
6.4 Main Effect plot for Means 87
6.5 Main Effect plot for Signal-to-Noise ratios 89
6.6 Interaction plot for Means 91
6.7 Interaction plot for SN ratios 92
LIST OF ABBREVIATIONS AND SYMBOLS

A, B, ..... - Variables used in the design of experiment
Ai - The average of observation under condition Ai
DOE - Design of experiment
e - Experimental error
f - Degrees of freedom
F - Variance ratio
L - The Taguchi loss function
L8 - An orthogonal array has 8 experiments
MSD - Mean square deviation
N - The number of experiments
OA - Orthogonal array, L4, L8, L16, etc.
P - The percent contributions of a variables
S - The sum of squares
S/N - The signal of noise ratio
T - The sum of all observation
V - The variance
Y - Result measured in term of quality characteristic
CHAPTER 1

INTRODUCTION

This chapter commences with the background which introduces the concepts of eliminating waste and thereafter associated problems are highlighted. The objectives and scope are outlined and they make way for the purpose of this project report. The chapter ends with the organization of the report.

1.1 Background

Mankind has always had an interest with quality. Today’s technology bears declaration to man’s continual desire to provide a higher level of quality in product and services to increase market share and profits. Sometimes, quality is essential (Ranjit Roy, 1990). Driven by the need in order to compete on price, performance and to maintain profitability, quality conscious manufacturers are increasingly aware of the needs to optimize product and process. Quality achieved by means of design optimization is founded by many manufactures to be cost effective in gaining and maintaining a competitive position in the world market.

When the expression of quality is used; base to our perception about quality, we usually think in term of excellent product and service in order to fulfills or exceed our expectations. These expectations are depends on the intended use and the selling price. When the product surpasses our expectations, we consider that quality.
Genichi Taguchi was a Japanese mathematician and proponent of manufacturing quality engineering. He focused on methods to improve the quality of manufactured goods through both statistical process control and specific business management techniques. Taguchi developed many of his key concepts outside of the traditional Design of Experiments (DOE) framework and only learned of it later. His main focus was on robustness, how to develop a system that performed reliably even in the presence of significant noise or variation. In traditional DOE, the goal is to model the best-performing recipe. In other words, the higher the value of the output variable (e.g., the conversion rate), the better. So the goal is to find the highest mean. When taking repeated samples, any variation is considered a problem or a nuisance.

For the past five decades, Taguchi led what has been called the "quality revolution" in manufacturing around the world. In this comprehensive reference, which includes over 90 complete case studies, Taguchi and his co-authors explain his concepts, starting from his theories on managing for quality engineering from an historical perspective, the "signal-to-noise ratio" technique, robust engineering, the Mahalanobis-Taguchi System, testing, on-line quality engineering, experimental regression, and the design of experiments. After the presentation of all the case studies, which are sorted by concept as well as industry, Taguchi compares his methods to those of other "quality philosophers" such as Deming.

Taguchi address quality in two main areas: off-line and on-line quality control (QC). Both of this area are very cost sensitive in the decision that are made with respect to the activities in each. Off-line QC refers to the improvement of quality in the product and process development stages. This phase of Taguchi methods addressed the positive impact on cost that is obtained by improving quality at the earliest times in a product life cycle. On-line QC refers to the monitoring of current manufacturing processes to verify the quality levels produced. The Taguchi on-line QC approach is a cost quality perspective ad someday should be recognize as an alternative quality control system.
1.2 Problem Statement

In a disk manufacturing, there are a many problem occur due to reject rate. There are a lot of products that have been produce in Production Department. Besides that, there are some reject products in production line or process such as Outer Kake, Inner Kake, Nokori, Ware, Kan, ID small, OD small, Outer chipping, Inner chipping, Awa, Dummy and others. This company organizes a team to improve the reject quantity of disk. The improvement focuses on Awa reject type. Awa means bubble inside the disk that produced. There are few adjustment on parameter that influence the reject rate. The research is focus in reject product in the productions. This research try to reduce the higher percentage of reject product per production rate to lowest percentage per productions and try to improve the productivity in this company.

1.3 Objective

1. To determine and identify the root cause of quality problem faced by production line.
2. To establish the best or the optimum condition for a process of discs production shop-floor.
3. To optimize the production of shop-floor by increasing the quantity of good product through minimizing the waste with new setting parameter.
4. To recommend a new improved production parameters from the finding of research analysis.

1.4 Importance of the Project

1. Development of method or solution to improve the production.
2. Increase efficiency and reduce the reject material in production system.
3. To reduced mistakes by the process or system in discs production shop-floor.
4. To recommend the best method in order to achieve the high quality of product in production.
1.5 Scope and Limitations

There are many departments in the company. This project tries to apply the Taguchi method to one department of Ohara Company. Since the major contributor to root cause of reject came from Pressing Section in a Production Department, this section was chosen for conducting the research. Due to limitation of time and energy, only one product i.e. glass substrate type TS-10X was taken as the object of research. The focus of this research is also limited to Awa (Bubble) reject type to improve the production and reduce the quantity of reject product.

1.6 Organization of the Thesis

Based on the thesis for Projek Sarjana Muda (PSM) I & II, an organization has been constructed for the process flow of completion in order to fulfill course of Degree in UTeM. Below shows the format of the organization:

Chapter 1: Introduction

This chapter covers the background of quality and Taguchi Method, objectives of study, problem statement, scope of study and the organization for the thesis.

Chapter 2: Literature review

This chapter begins in explanation of the history of development of quality management, following by the definition of Taguchi Method. Then, summarized all the journals finding that related to the product quality based on quality and Taguchi Method was done. Last, different types of tools are used in order to overcome the current problem that occurs in the journals’ finding.
Chapter 3: Methodology

This chapter represents the flow chart that carried out for the whole process of the methodology. Besides, the data collection that includes the primary resources and secondary resources is done in order to obtain all the related information for analysis the problem.

Chapter 4: Case Study

This chapter illustrates the company background; it is primarily focused on the production line of chipset manufacturing. Then, it describes the process at NGBA module in detail.

Chapter 5: Process Development

This chapter provides the process to construct the Taguchi Design of quantity reject product in disk manufacturing. This chapter also explains about the process to construct the Taguchi Design step by step.

Chapter 6: Result & Analysis

This Chapter begins with presenting the data collected through this project. Thereafter, the data on current state is discussed in order to achieve improvement in future state. A comparison of the data set at current state and future state is presented as well. The optimum solution obtained for the solution. Finally, the reduction of waste is discussed in terms of cost saving.

Chapter 7: Conclusion & Recommendation

This chapter concludes the whole project and at last reflections around the project together with suggestions for further project are discussed.
CHAPTER 2

LITERATURE REVIEW

In terms of a literature review, "the literature" means the works that consulted in order to understand and investigate the research problem. The review should describe, summarize, evaluate and clarify. This literature review explores the dominant themes includes study and research of published materials like journals, thesis, case study, technical document, and online library. Generally, the purpose of a review is to analyze critical segment of a published body of knowledge through summary, classification and comparison of prior research studies, reviews of literature, and theoretical articles.

2.1 Introduction

This chapter will describe topics that related to quality such as definition of quality, type of quality, quality dimensions, Taguchi Method methodology, Taguchi method approach, and other relevant quality topics. Emphasize is more on Taguchi methodology since the study conducted in a Taguchi method manner.

Taguchi Method will describe more on the definition of that phase, the background and basics of Taguchi method, the characteristics of Taguchi method, the benefit on implementing or using Taguchi method, the Taguchi test, and the relevant topics that related with Taguchi method.