DMAIC METHOD APPLICATION TO REDUCE CONTAMINATION IN HARD DISK DRIVE

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A master project report submitted
As a partial fulfillment of the requirements for the degree of Master of
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Faculty of Manufacturing Engineering

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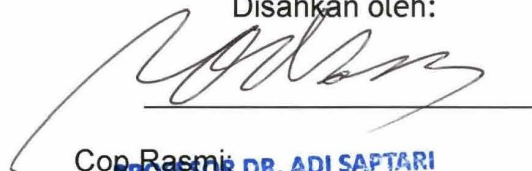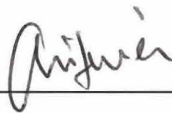
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DECLARATION

I hereby, declared this master project report entitled "DMAIC METHOD APPLICATION TO REDUCE CONTAMINATION IN HARD DISK DRIVE" is the result of my own research except as cited in references.

Signature	:	....
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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Master of Manufacturing (Manufacturing System Engineering). The member of supervisory committee is as follow:

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DEDICATION

For my family, thank you for all the support and patience.

ABSTRACT

Contamination issue is one of the major problems present in the hard disk drive. As the demand of storage capacity gets higher, the flying height of head relative to the disk is the lower the better for read and writes function. Hence, it is critical if there is any single contaminant present in the drive. The presence of any contamination in the hard disk drive will eventually cause the drive to fail directly or intermittently. In another word, the defect will be occurred. This would definitely a waste that wish to be omitted in every single company. DMAIC (Define Measure Analyze Improve and Control) method applied on this research. The objectives are aimed to identify major contamination in HDD production, analyze the root cause of HDD contamination and then propose effective corrective actions to reduce the contamination in HDD production.

ABSTRAK

Isu pencemaran di pemacu cakera keras adalah salah satu masalah yang wujud lama. Iadisebabkan permintaan untuk kapasiti yang lebih tinggi akan menyebabkan penerbangan kepala kepada cakera lebih rendah untuk mendapatkan isyarat penulisan and pembacaan yang lebih baik. Oleh itu, kehadiran sebarang bahan pencemar di pemacu cakera keras adalah sangat kritikal. Kehadiran bahan pencemar di pemacu cakera keras akan menyebabkan ia gagal untuk berfungsi dengan baik. Oleh itu, defek dalam pembuatan akan terjadi. Ini adalah salah satu pembaziran yang setiap satu organisasi berharap untuk dielakkan. Cara DMAIC telah dipergunakan dalam kajian ini. Tujuan kajian ini adalah untuk menyelesaikan masalah yang telah wujud sekian lama. Tujuan utama adalah mengenalpastikan pencemaran yang paling ketara di industry pembuatan pemacu cakera keras menganalisis punca-punca masalah dan mencadangkan cara penyelasaian yang efektif untuk mengurangkan pencemaran di industry pemacu cakera keras.

ACKNOWLEDGEMENT

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LIST OF ABREVIATIONS

ABS	-	Air Bearing Surface
AOQL	-	Acceptable Outgoing Quality Level
BA	-	Backend Assembly
BB	-	Bow bending
BVCM	-	Bottom Voice Coil Magnet
CA	-	Corrective action
DFH	-	Dynamic Flying Height
DLC	-	Diamond-like-carbon
DMAIC	-	Define, Measure, Analyze, Improve, Control
ESD	-	Electro Static Discharge
FQA	-	Final Quality Assurance
FR	-	Failure rate
FY	-	Fiscal Year
HDA	-	Hard Disk Assembly
HDD	-	Hard Disk Drive
H'SA	-	Head stack
ID	-	Inner Diameter
IE	-	Industrial Engineering
ISPM	-	In situ particle monitor

MBA	-	Motor Base Assembly
MITEC	-	Manufacturing IT Integration System
NPPC	-	Non-plasma particle cleaning
NPI	-	New Product Introduction
NVA	-	Non Value Added
OD	-	Outer diameter
OEM	-	Original Equipment Manufacturer
OSA	-	Optical Surface Analyzer
PTFE	-	Polytetrafluoroethylene
QBR	-	Quarterly Business Review
SEM/EDX	-	Scanning Electron Microscope/Energy Dispersive X-ray Spectrometer
TAM	-	Total Available Market
TVCM	-	Top Voice Coil Magnet
TD	-	Touchdown
TD DVT	-	Touchdown Drive Verification Test
VMI	-	Visual Mechanical Inspection
WIP	-	Work In Progress

CHAPTER 1

INTRODUCTION

The main purpose of this chapter is to give an overview of the project to be studied. It includes background, problem statement, objectives, scope and significance of the study.

1.1   Background

Company AB is founded in 1970 as a specialized semiconductor company and entered storage business in 1981 with first hard drive controller. Company AB entered hard drive business since 1988. Apart from other competitors, Company AB is one of the world's largest and fastest growing hard drive suppliers with almost 96,000 employees worldwide. It possesses strong heritage in serving Original Equipment Manufacturer (OEM), distribution and retail markets. Besides, Company AB also participates in all traditional markets.

Based on current dynamics of Hard Disk Drive (HDD) markets, overall Total Available Market (TAM) appears to be stabilizing. The growth of demand of HDD correlates with the growth of market Personal Computer (PC), Note book, desktop and so on. It also depends on success of new thin and light systems and Windows 8 touch-enabled systems as well as macro-economic recovery. Enterprise remains healthy based on continuing public/private cloud build-out. Personal storage market is experiencing growth with opportunities related to the Company AB Connected Life initiatives.

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Basically, HDD customer is looking for reliability (Annualized Failure Rate) and quality (Line Integration). Besides that, speed and performance also is an importance criteria customer emphasizes. The HDD production around the world needs very clean production room, any particles may deteriorate the quality of product.

1.2   Problem Statement

Contaminations issue is one of the problems faced in almost all HDD industries. Any foreign particles that present in the drive itself will cause the drive to fail directly or intermittently. This creates products scrap and rework. Eventually it will reduce company's productivity, as it will use up the company's resources of machine, labor and materials. So it create a waste, any waste in lean thinking should be eliminated.

There are a lots of contamination sources in HDD production. Some of these are necessary to be eliminated, as it will deteriorate the reliability and quality of the product. If the drive that fail intermittently and was unable to capture by any of the testing process which then escape to the customer side will eventually lead to the customer unsatisfied. This is the undesirable result to be seen. Hence, this study will focused few of these contaminations, and proposed a solution to reduce its contamination rate by implementing effective corrective action.

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1.3   Objectives

The objectives of this study are:

1. To identify major contamination in HDD production.

2. To analyze the root cause of HDD contamination.

3. To propose effective corrective actions to reduce the contamination in HDD production.

1.4   Scope of the study

This research will be conducted at the Analytical Service Laboratory and clean room at Asia Company AB. The product to be focus on is only Product A program. The failed drives studied were mainly from reliability, line and Final Quality Audit from FY12Q1 to FY13Q3 (Total: 1 year and 9 months).

1.5   Significance of the study

The value for this research is mainly contributes to the hard disk drive industry. For the HDD company itself (in this case, Company AB), the manufacturing cost per unit drive can be reduced by increasing the yield which has zero defect in term of contamination. The work in progress (WIP) hold for failure analysis can be reduced as well by reduction of contamination issue. Indirectly, workers are free from the said contamination issue and thus can concentrate on other improvement. Whilst for the customer side (retailer and end user), the customer can get a good quality of drive with short lead time.

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CHAPTER 2

LITERATURE REVIEW

This chapter mainly discusses contamination issues on the previous researches that have been done in the Hard Disk Drive (HDD) and also the importance of contamination control in the HDD's reliability as the higher storage capacity is needed nowadays.

2.1. HDD Production

The manufacturing of Hard Disk Drive (HDD) is conducted in class 100 clean room environment for contamination control. As shown in Figure 2.1, Bottom Voice Coil Magnet (BVCM) and Inner Diameter (ID) crash stop will be installed on the Motor Base Assembly (MBA). Then Media and disk clamp will be installed on the MBA, and clamp is fasten with screw. Followed by that is imbalance measurement where motor is spin up to verify the initial imbalance of the hard disk assembly both XY and Z planes. Auto Wire Install is to minimize the imbalance of the hard disk assembly by inserting at specific angle; or by inserting plugs into spindle motor holes. Then, the ramp is installed. The Head Stack Assembly (H'SA) and Top Voice Coil Magnet (TVCM) is installed on the MBA by robotic arm. Followed by that is Outer Diameter (OD) crash stop installation. After the H'SA is being placed into MBA, the next step would be merged the H'SA into ramp. The drive is going to Drive Cleaning Process station in the HDA before top cover install. Once all the components in HDD are being placed

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into their position accordingly, the top cover is assembled on the MBA to enclose it. Lastly, the seal is being installed before the drive is going out from clean room.
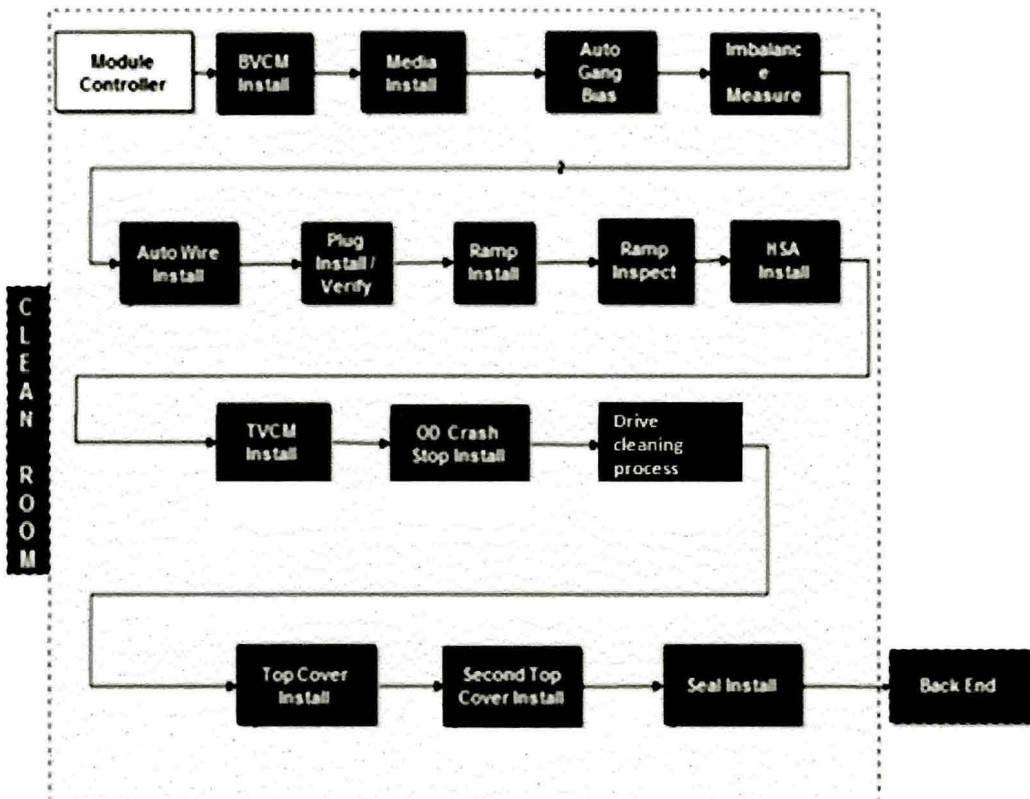

Figure 2.1 HDD assembly in clean room (Company AB, 2013)

By referring to Figure 2.2, the completed assembled drive is then proceeds for various backend tests and software/command set up. The tested drives will be label accordingly for traceability and then going through Visual Mechanical Inspection (VMI) before packaging.
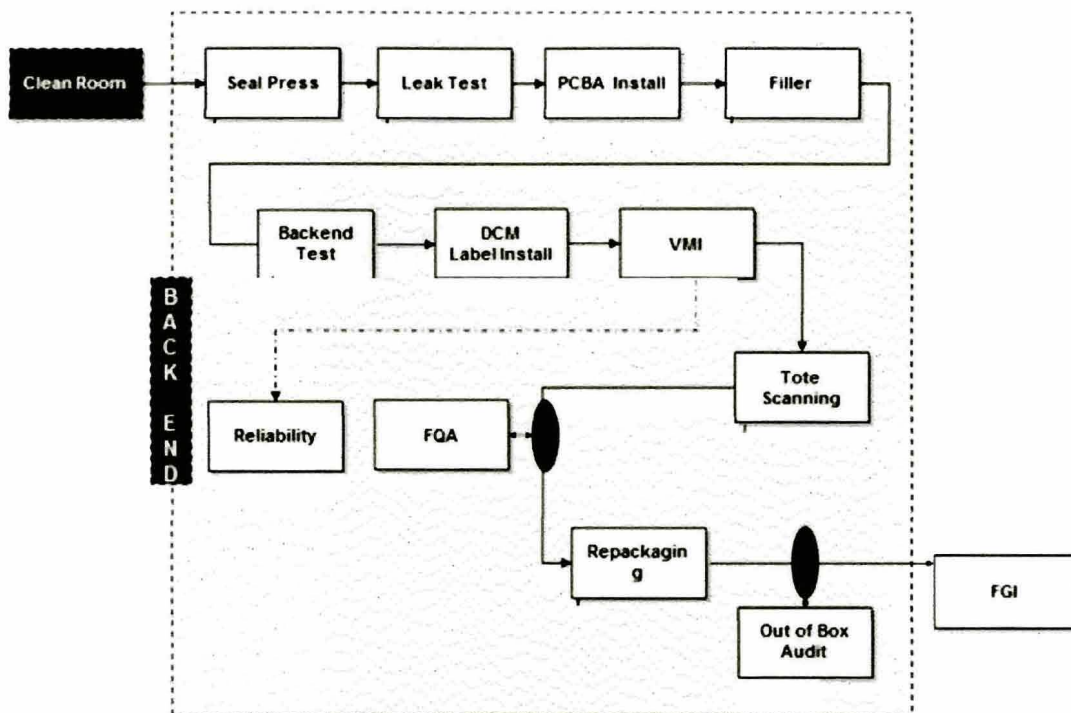
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Figure 2.2 HDD backend process (Company AB, 2013)

2.2 Contamination issue in the hard disk drive

Sung-Eun Park *et al.* (2006) states that the hard disk drive is the most general data storage device owe to its extensive storage capacity and low cost. The pace of development of the magnetic disk drive since its conception in the early 1950's has been such that it is now a standard component in all except the smallest hand held computer system. The low flying height of the head over the media surface as shown in Figure 2.3 indicates there is necessities a tight control of the operating environment.
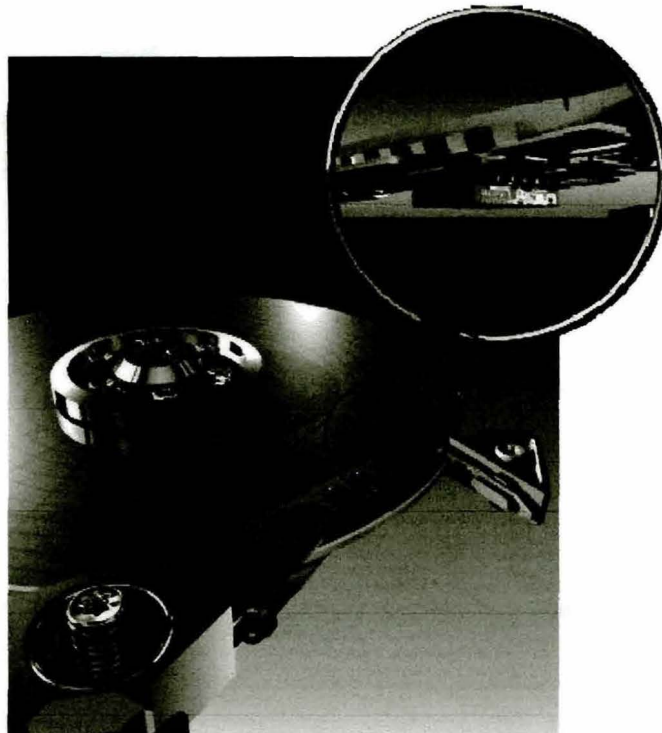
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Figure 2.3 Low flying height of slider to media (Company AB, 2013)

Any dust particles, finger prints and other contaminants can cause the head to "crash" on the media surface resulting in damage to the head and media and the possible loss of valuable stored information. Figure 2.4 shows the relative dimensions of some possible contaminants compared to the flying height of the disk. Different size of contaminant gives different impact to the slider as a result of collision. In order to reduce contaminant in HDD, the sealed enclosure is used to house the media and the head assembly. In addition, the air within the enclosure is cycled through a fine filter.
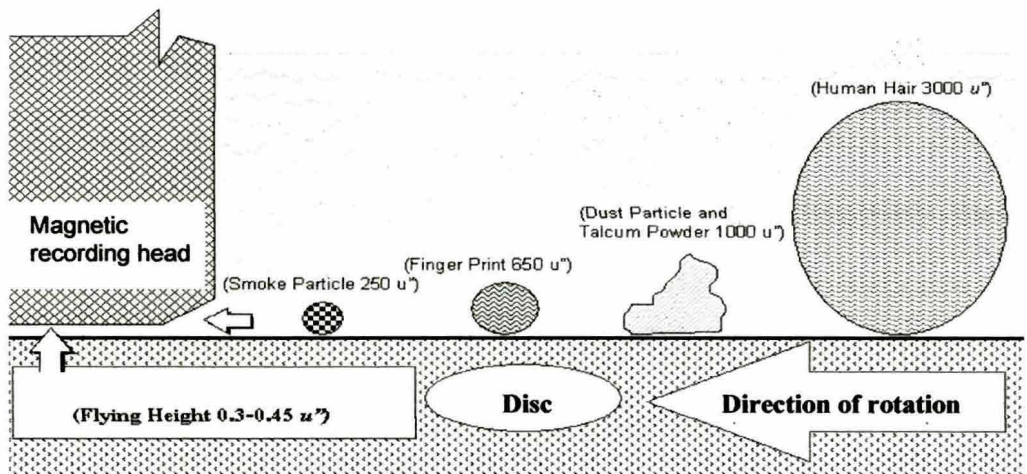
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Figure 2.4 Flying height and various contaminant size comparison (Company AB, 2013)

The stability and reliability of HDD is getting important nowadays as storage capacity and areal density of hard disk drive increases. Since the rotational speed of hard disk is increased and the gap between the drag force head and disk are more likely come in contact for increase storage Capacity, the generation of particle contamination was also increased and its effect on drive reliability came up very importantly. The technology is moving towards contact recording and the flying height has been reduced to under 1μin in some of today's disk drives. As a result, contamination control becomes a serious topic in reliable disk drive design. Therefore it is important to study how flying particles in disk chamber may lead to disk wear and head-disk interface (HDI) failure (Bo Liu et al., 1996).

Research carried out by Myung et al. (1994 cited in Hee-Sung Park et al., 1999) mentioned that the study in reducing the spacing between the head slider and the disk has been conducted out aggressively in order to improve the areal density of the disk surface. According to Chung et al. (1997) and Copper et al. (1996), the moment this technology was

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