# PRODUCTIVITY IMPROVEMENT FOR A HARD DISK DRIVE INDUSTRY BY REDUCING MACHINES DOWNTIME OF AUTOMATED HEAD GIMBAL ASSEMBLY LINE

**Conference Paper** · January 2015



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# PRODUCTIVITY IMPROVEMENT FOR A HARD DISK DRIVE INDUSTRY BY REDUCING MACHINES DOWNTIME OF AUTOMATED HEAD GIMBAL ASSEMBLY LINE

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**ABSTRACT:** The hard disk drives Industry is one of the most important businesses in Thailand having the export value for $11.8 US billion dollars in 2013. Therefore, improving the productivity and process for enhancement the global competitiveness of the company is crucial. The case study company has set the policy to modify its semi-automated assembly line to be the automated assembly line in order to improve the productivity and rapidly produce the products. However, after installing the new automated assembly line, it turns to increase the downtime more than in the past. Therefore, this paper aims to reduce machine downtime. We have studied, analyzed the causes of machines breakdown and further to find out the method for alleviating this problem. As these aspects, the 7 tools of quality principles, which using the causes and effect diagram and check sheets, are implemented. In addition, the 7 wastes technique focusing on waiting and inefficiency of the process are also considered. It can be concluded that the alternatives method for solving this problem can reduce the downtime of assembly line from 44% to be 28% of total production time.

## 1. INTRODUCTION

The HDD industry has long held paramount significance for the country, as Thailand has supplied nearly half of the world's HDDs since 2005. [11].This product can make the export value to Thailand approximately $11.8 US billion dollars in 2013 [12]. The case study company is one of the leading companies producing HDD. Due to the highly competitive business, the company attempted to produce the product faster for responding the customer needs. Head Gimbal components are one of the essential components of HDD. The company has changed its semi-automated assembly line of head gimbal part to be automated line. After implementing the new line, it has faced with the problem of increase machine downtime. The process of HGA (Head Gimbal Assembly) consists of 8 steps as illustrated in figure 1. Machine down times in September 2011 of the new automated line are up to 44% of total production time as shown in figure 2. As this problem, investigation the causes of machines down time have been performed. The method and steps of this research work will be presented in the next section.

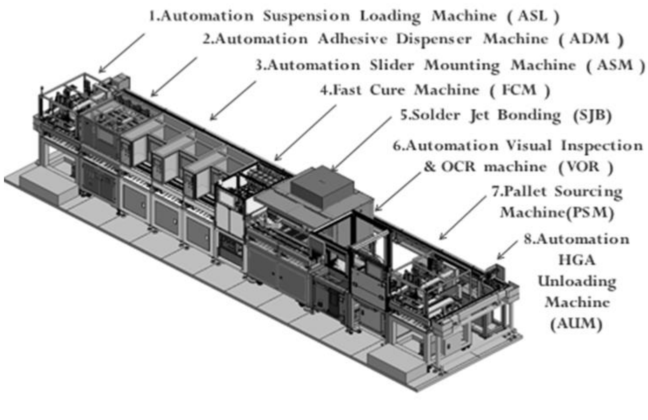


Fig 1 Manufacturing process of HGA component

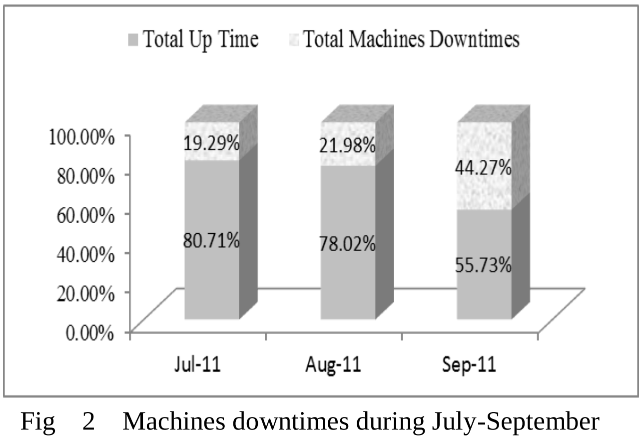


Fig 2 Machines downtimes during July-September 2011

## 2. METHODS

HGA is one of the part components of HDD (Hard Disk Drive) product. Figure 3 represents the example of HDD product. It consists of two main components which are the Head Gimbals Assembly-

HGA and Head Stack Assembly-HSA. HGA is the focused component of this research; its components are also shown in figure 4.There are some researchers studying in the HDD industry for improving the productivity. Chutima et al. have researched the factors affecting the swaging process of Head Stack Assembly process [13]. Kaewka, and Tangchaichit have also studied the swaging process of HDD by using finite element for analyzing the optimal the actuator arm material [1]. Lerswanichkul and Rojanarowan focused on the testing machine of Head Gimbal Assembly process using discriminant analysis technique for reducing the testing activities [2]. Temsuwanpanich and Kengpol have reduced machines downtimes of the Head Gimbal Assembly process focusing on the testing machine [3]. The optimal buffer capacity for accommodating machine breakdown has been proposed for solving the idle time [4-5]. Some researchers have analyzed the formula of throughput time with identical stations and random failures [6-7]. Fox et al have concerned with the financial impact of machine downtime for the sorting machine of the post office [8]. In addition, root cause analysis of machine breakdown in metal process industry has been proposed [9]

However, the studies for reducing machine downtime of the automated line in HDD have not been proposed. This study has analyzed the data of machine downtime in the case study company. The techniques have been used in this research are described in the following subsections.

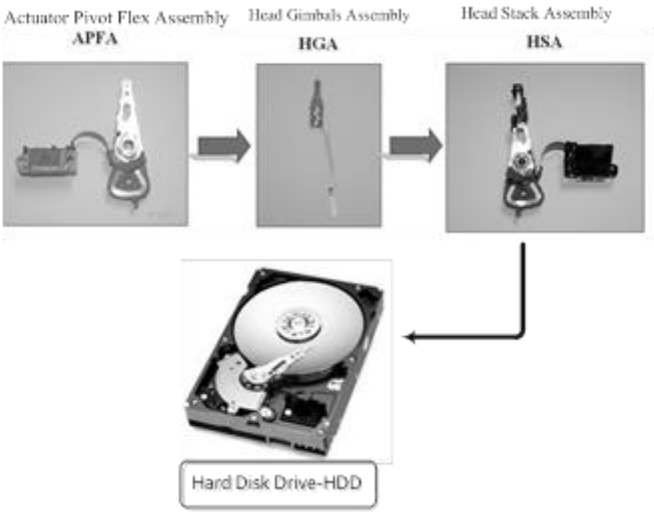


Fig 3 Two main components of HDD

2.1 Principles of 7 wastes

The way to improve company profits is to reduce the costs; this means removing all elements of wastes from manufacturing processes. In addition, the company will find that waste has a major impact on customer's satisfaction with the products and services. The customers want on time delivery, perfect quality and at the right price. Recognition on 7 wastes within the processes will help to improve the process [14]. Lean manufacturing is the systematic elimination of 7 wastes which are overproduction, waiting, transportation, inventory, motion, over-processing, defective units. In this study, the wastes of waiting have been analyzed.

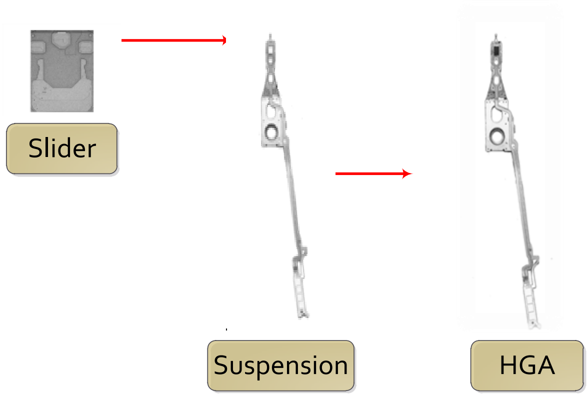


Fig 4 Detailed components of HGA

2.2 QC 7 tools

The 7 QC Tools are simple statistical tools used for problem solving. For solving quality problems seven QC tools used are Pareto Diagram, Cause & Effect Diagram, Histogram, Control Charts, Scatter Diagrams, Graphs and Check sheets. All this tools are important tools used widely at manufacturing field to monitor the overall operation and continuous process improvement [10]. Pareto diagram and Cause & Effect diagram are employed in this study.

The data of the case study company will be analyzed which are described in the next section.

## 3. ANALYSING PROBLEMS AND SOLUTIONS

As mentioned in figure 2, the problems of machines downtimes are up to 44% in September, 2011. Therefore, the data of machine breakdown in this month has been analyzed. However, the total time in the plant has been classified into two types as shown in figure 5. First, it is non-scheduled time which is not considered in this research. Second, it is operation time which is further divided into two subtypes which are uptime and downtime. The downtime in this subsection has been studied for improving which will be described in the next subsection.

3.1 Analyzing Problems

The weekly machines downtimes of September 2011 are illustrated in table I. The non-scheduled time has not considered in this table. Machines downtimes of week 5 are higher than the others. As this data, investigation the causes of downtime has been performed. Cause and effect diagram has been conducted for indicating the causes which shown in figure 6.

Machines errors are the major problem. Therefore, all machines in the HGA process have been analyzed in figure 6. The results are shown in figure 7 describing that five machines ranked in top breakdown are Solder Jet Bonding (SJB), Automation Suspension Loading Machine (ASL), Automation Unloading Machine (AUM), Automation Adhesive Dispenser Machine (ADM), and Fast Cure Machine (FCM). All of them have breakdown times more than 10%. Therefore, they are the focused areas of this research for downtime reduction.

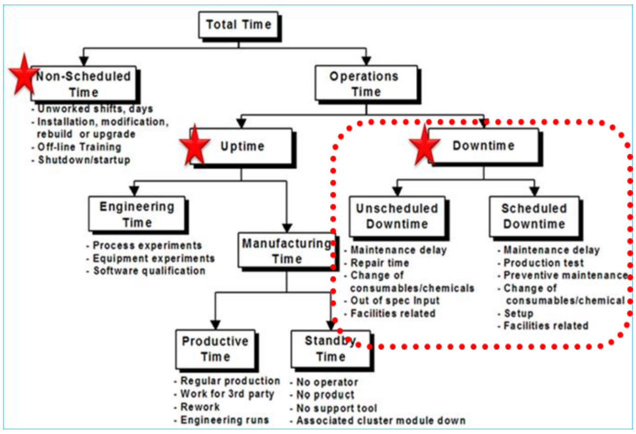


Fig 5 Classification of relevant times in HDD manufacturing

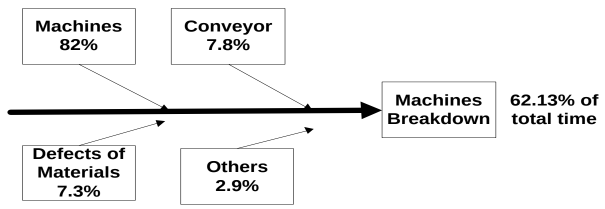


Fig 6 Cause and effect diagram of Machines Breakdown in week 5 of September, 2011

Table I The weekly data of machines downtimes of September, 2011

| | Sep-11 | | | | | |
|---|---|---|---|---|---|---|
| | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Average |
| %Downtime | 22 | 28.19 | 53.2 | 55.92 | 62.13 | 44.288 |
| % Uptime | 78 | 71.81 | 46.8 | 44.08 | 37.95 | 55.728 |
| Engineering Time | 9.58 | 15 | 0 | 1.41 | 0.41 | |
| Standby Time | 29.16 | 19.58 | 14.05 | 3.04 | 4.67 | |
| □ Productive time | 39.26 | 37.22 | 32.75 | 39.64 | 32.87 | |

3.2 Problem Solving Techniques

The problems of major five machine types have been classified illustrated in table II. The percentage summation of main problems accounting higher than 70% of each machine is recognized. However, some problems have been solved. They are indicated with highlighted text in table II. Due to some problems consume the long-time of improving. Therefore, this study will propose the ways to improve some problems that can be modified easier indicating with highlighted text in table II. For solving these problems, the techniques for reducing machine downtime have been proposed which are shown in table III

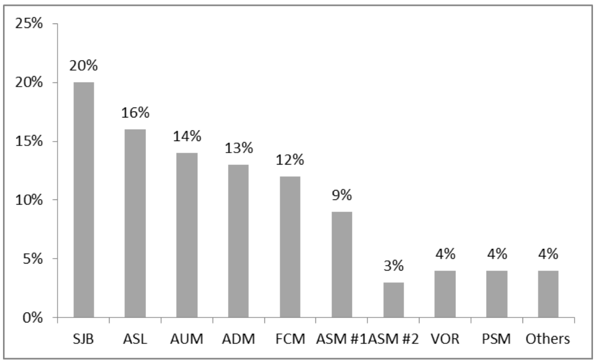


Fig 7 Pareto chart of machines downtimes

Table II Main problems accounting more than 70% of five machines

| Machine | Problem Description | % Ratio of m/c Downtime |
|---|---|---|
| SJB | Double pallet stack | 24.3 |
| | Conveyor time out | 19 |
| | Robot error | 13.3 |
| | Change capillary and solder ball | 12.1 |
| | Reading barcode error | 9 |
| | Machine hang | 8.8 |
| ASL | Machine hang | 38.1 |
| | Tray shuttle error | 14.3 |
| | Tray unload stacked erroı | 9.8 |
| | PnP pick up error | 8 |
| | Loosen sensor | 7.2 |
| AUM | Data sent error | 41.8 |
| | Machine hang | 29.7 |
| | PnP loading misalign | 5.8 |
| ADM | Pallet stuck | 43.5 |
| | Machine hang | 22 |
| | Conveyor time out | 16.6 |
| FCM | Pallet stuck | 37.4 |
| | Reading barcode error | 22.5 |
| | Update software | 15.2 |

Table III Solving techniques for reduction of machine downtime

| Problems | M/C | Solving Techniques |
|---|---|---|
| 1.Double pallet stack | SJB<br>ADM<br>FCM | 1. Install the testing machine to monitor the movement of robot and conveyor for loading and unloading machine.<br>2. Adjust the movement time for consistency of robot and conveyor, otherwise the pallet that unloaded from the robot may stack the pallet on the conveyor. |
| 2.Machine hang and update software | ASL<br>AHU<br>ADM FCM | 1. Check the program version and its problems<br>2. Update or change the old program depending on the problem faced.<br>3. Record the program having problem to be modified or abandoned. |
| 3.Tray shuttle error | ASL | 1. Operators inspect the alignment of suspension with visual control. If there are disorder suspensions, they should be rearranged<br>2. In the long term, the equipment for supporting the order arrangement of suspensions on the tray should be added. |
| 4.Tray unload stacked error | ASL | 1. The inspector must check in detailed every time of operation and then record data for preventing errors.<br>2. Construct the check sheet of recording data by real time for the precision result and notification errors. |
| 5. Data sent error | AUM | 1. Record the version of the program which has errors for modifying or abandoning.<br>2. Check the version of the error programs<br>3. Update or change the program depending on the situation. |
| 6. Change capillary and solder ball | SJB | 1. Construct the table for checking equipment before and after operation.<br>2. Record data of equipment which damage before the maintenance program for repairing it before out of order.<br>3. Fill the maintenance work in the action plan |

## 4. RESULTS AND DISCUSSION

As implementing the 7 wastes concepts, this study has reduced the waiting times which are machines downtimes. The main factors of downtimes are come from machines of manufacturing. After analyzing the causes of problems, the solving techniques have been proposed. The estimated downtime of machines has been reduced by 44.64% as illustrated in table IV. However, when considering in figure 6, the main problems of machines downtimes is machines breakdown accounting for 80%. Therefore, the machines downtimes can be reduced by 36.6% as summarized in table V. Furthermore, the real machines downtimes reduced have been calculated which are approximately 16.8 as shown in table VI. It can be summarized that machines downtimes after improving are 28.07%.

In addition these solving techniques, the optimal of buffer inventory should also be recognized and integrated in the process [4-5].

Table IV: Summary of %Reduced Downtime of Solving Machine Problems

| M/C | Problem Description | %Total of Downtime/ Machine | % Ratio of M/C Downtime | %Reduced Downtime | % Sum of Reduced Downtime |
|---|---|---|---|---|---|
| SJB | Double pallet stack | 20 | 24.3 | 9.04 | 44.64 |
| | Change capilary and solder ball | | 12.1 | | |
| | Machine hang | | 8.8 | | |
| ASL | Machine hang | 16 | 38.1 | 9.95 | |
| | Tray shuttle error | | 14.3 | | |
| | Tray unload stacked error | | 9.8 | | |
| AHU | Data sent error | 14 | 41.8 | 10.82 | |
| | Machine hang | | 29.7 | | |
| | PnP loading misalign | | 5.8 | | |
| ADM | Pallet stuck | 13 | 43.5 | 8.52 | |
| | Machine hang | | 22 | | |
| FCM | Pallet stuck | 12 | 37.4 | 6.31 | |
| | Update software | | 15.2 | | |

Table V: Ratio of Reduced Downtime with Solving Problem of Machines

| Casuses of Problem | %Ratio Downtime | %Sum of Reduced Downtime from table IV | %Ratio of Reduced Downtime |
|---|---|---|---|
| 1. Machine | 82% | 44.64% | 36.6% |
| 2. Conveyor | 7.8% | | |
| 3. Defect of Materials | 7.3% | | |
| 4. Others | 2.9% | | |

Table VI Summary of %total machines downtimes after improving

| Before Improving | After Improving | | |
|---|---|---|---|
| (1) % Total Machines Downtimes (from figure 2) | (2) %Ratio of Reduced Downtime (from table V) | (3) = (1)*(2) %Real Reduced of Machines Downtimes | (4) = (1)-(3) %Total Machines Downtimes |
| 44.27% | 36.60% | 16.20% | 28.07% |

## 5. ACKNOWLEDGEMENT

The authors would like to express sincere thanks and appreciation Mr.Sunti Pumkrajang the production manager of Western Digital Co., Ltd and the anonymous people in this company for supporting data and allowing the researchers to study the manufacturing process of the company.

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