CHAPTER 1

Introduction

1.1 Background

The company is producing Head Gimbal Assembly (HGA) which is a component of hard-disc drive in a computer. HGA is the most important component because its responsibility is on how to write data to the disc and read data back from the disc. Figure of HGA is shown in Appendix A.

After HGA is assembled via multiple operations in HGA process, it will be tested the ability in flying of HGA on the disc by Fly tester and the ability in writing and reading of HGA on each parameter by Electrical Tester (ET) before packing and shipping to customers. In this thesis, process of monitoring ET performance, shown in Appendix B, is focused that there are now approximately 400 electrical testers in the factory.

To test HGA products accurately, testers have to operate efficiently. If there are some errors or abnormal conditions occurring in the testers, they will affect to the testing operation. To ensure that testers are functioned properly, knowledge of statistical process control (SPC) is used to monitor and control tester performance. This method is called "*TSPC*" which is used to monitor the tester conditions of electrical testers. Actually, there are two purposes of performing TSPC. One is to confirm tester's status after there is the calibration or hardware change. Another is to monitor whether the tester is in normal condition after used for a certain period that TSPC is run in routine. This thesis is focused on the latter case that is TSPC in routine run to examine the tester condition during it is being used. Running TSPC is shown in Appendix C to see the overview picture of operation.

Performing TSPC requires standard parts that are selected from the production. These parts will become the standard parts if they pass secondary standard generation process that would be explained in Chapter 3. This process screens HGAs by concerning on repeatability illustrated in covariance (COV) that different parameters have different maximum COV criterion. If a part has the COV less than the maximum value, it is chosen to be the standard part that will be used as "*TSPC part*". In determining COV, each part has to be tested three times that the average of the test readings will be used as assigned values or references of parts for each controlling parameter.

Test Technical Operator (TTO) is the operator who is responsible for performing TSPC. TSPC must be run to confirm tester condition at least once a day. For performing TSPC, testers are arranged into groups using the same standard parts. Each group consists of up to 18 testers in the vicinity location.

TSPC process is started from picking up three pairs of TSPC parts, 3 of which are up-HGA and the other three parts are down-HGA, from standard parts. These parts have known readings which are the reference values on controlling parameters. These parts will be checked by visual inspection. Then, the media or disc that is used to store data, shown in Appendix D, has to be ensured for its cleanliness, no contamination, and no scratch. If the disc has a scratch, it must be changed. Every time the disc has been changed, *disc factoring* is needed to compensate media variation which varies from surface to surface. This calibration requires at least 5 reference parts called "*factoring parts*" to be run across the tester to find factor that will make that surface gives the reading which correlates to gold value. As well as TSPC parts, factoring parts could be obtained from secondary standard generation process as well. In performing TSPC, the same sets of both TSPC parts and factoring parts have to be used in a group.

After TSPC parts and disc are verified, these TSPC parts will be run so that the reading values could be obtained. Each part is calculated to determine the difference, defined as parametric delta, of readings and references, and those three parts will be averaged to determine the final delta of each parameter. The final delta is the average of delta which is already removed an outlier data point. The outliers in this calculation are defined as a parametric delta which are not in acceptance range calculated from R-chart. The outlier data are recorded as "*desported*" separated by parameter. If there are outliers more than one (two or three outliers), the final delta will not be qualified and will be reported as "*bad*" data. Then, the qualified final delta is plotted on the X-bar control chart. All of these statistical calculations can be done by NTSPC program that the example result and the graph of control chart on specified parameter is also illustrated in Figure 1.1.

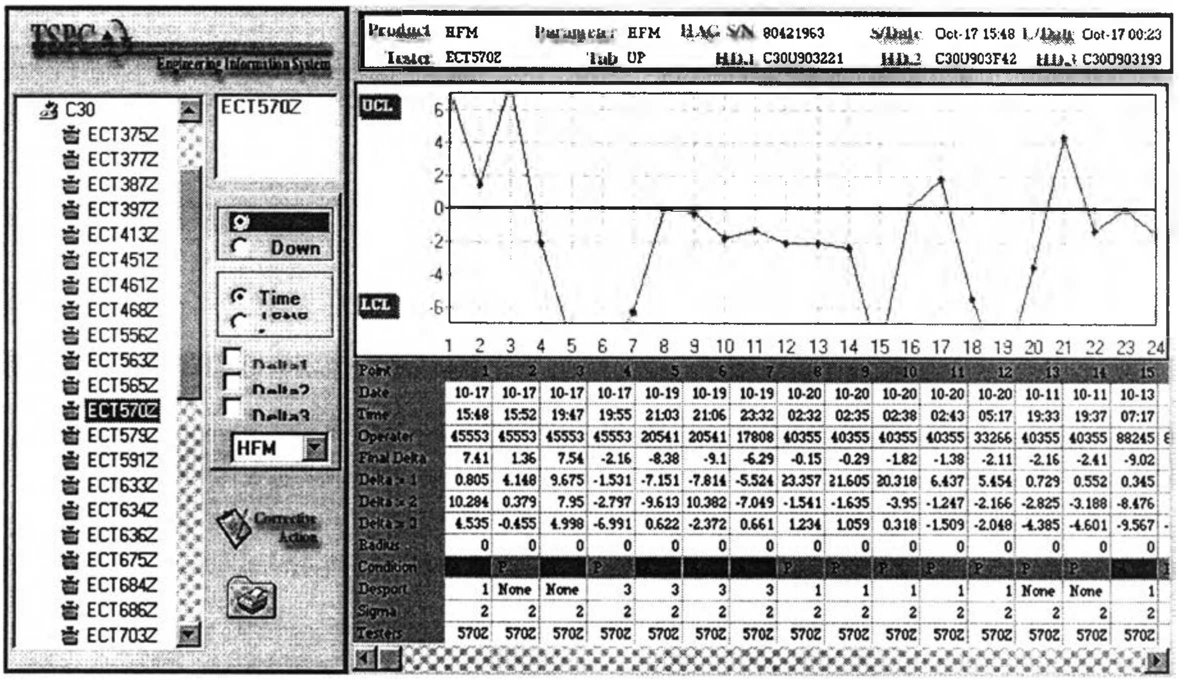

Figure 1.1: Example of the results and control chart from performing TSPC

If the final delta shows out of control, it indicates that there are something happened to the tester's performance resulting in appearance of assignable cause. Then, further investigation is required. TTO must notify the out of control root causes that the major root causes are the TSPC parts, factoring parts, disc, or tester issues. The TSPC parts, factoring parts, and disc problems are the responsibility of TTO to correct them by following the corrective action instruction for TTOs as shown in Appendix E. After that TSPC is necessary to be performed again for tester's condition confirmation. However, if the SPC data is still out of control after taking the corrective action by TTOs, the next cause that will be traced is the tester issues. Technician is responsible to verify the problems. The tester troubleshooting guide as shown in Appendix F is required for problem fixing. Then, the tester has to be confirmed by TSPC procedure again. If technician cannot find out the problems, which show out of control on TSPC chart, engineer is responsible to verify and find out for other root causes.

The procedure in performing TSPC can be drawn as the flow diagram shown in Figure 1.2.

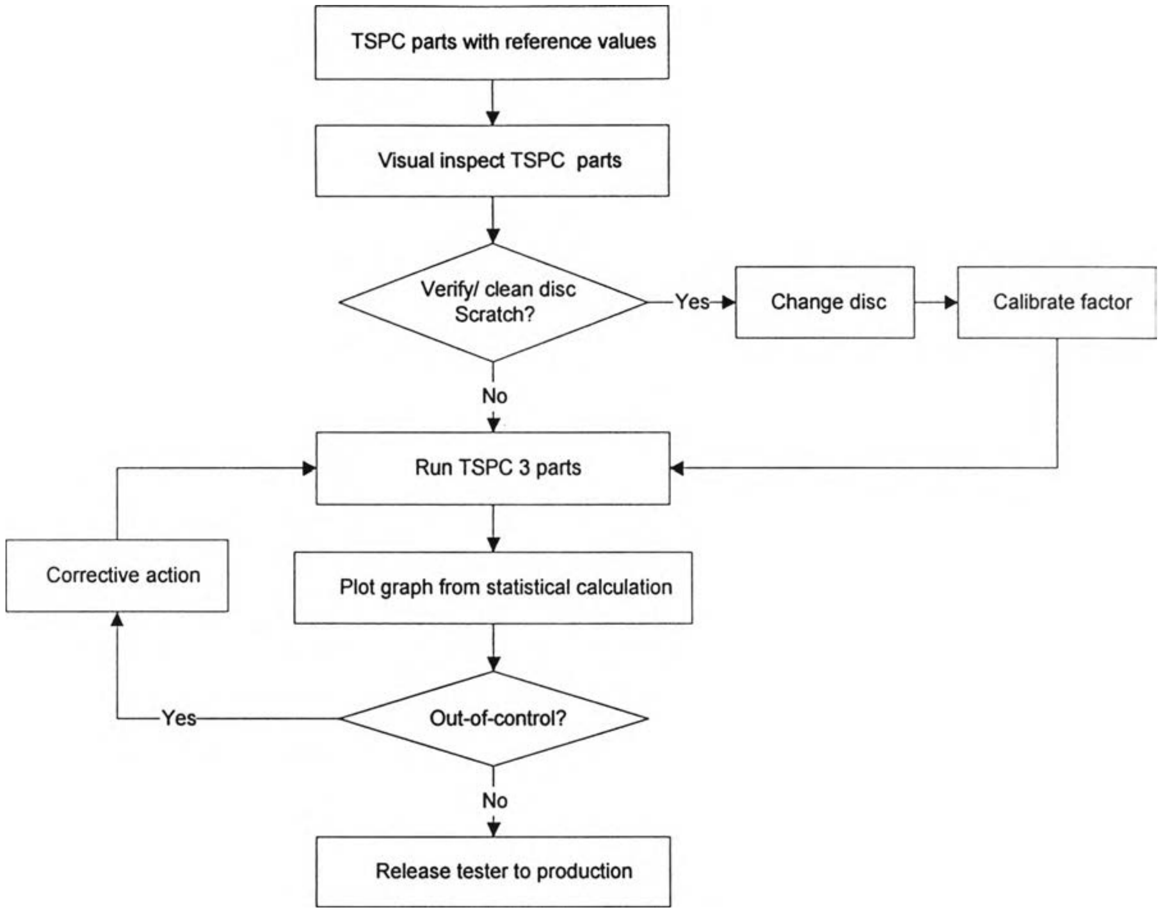

Figure 1.2: Process map of TSPC

1.2 Statement of Problems

The current TSPC is not effective enough to detect ET tester problems as found or indicated when SPC out of control is taken place. This results in unnecessary tester availability lost due to out of control corrective action and also with the usage of HGAs to support TSPC.

Performing TSPC provides benefits that can be concluded as below:

1. It is used to control tester performance and used as a tool to detect tester problems.
2. It is used to examine the differences of tester performance among different testers.

Although great benefits could be obtained from TSPC, the effectiveness of the current tool is relatively low (just about 30% effectiveness). Effectiveness is the percent of detection rate when SPC out of control is taken place which the root causes are from tester performance. In the other words, it is the percent detection rate of problems which occur from testing system, including factoring parts, disc, and tester issues, when out of control took place.

As shown in Pareto diagram in Figure 1.3, the major cause of problems comes from TSPC parts that are generated to be used in TSPC task. It is not worthwhile to do the corrective action while the cause of problems or out of control is not from the tester system which results in unnecessary operations.

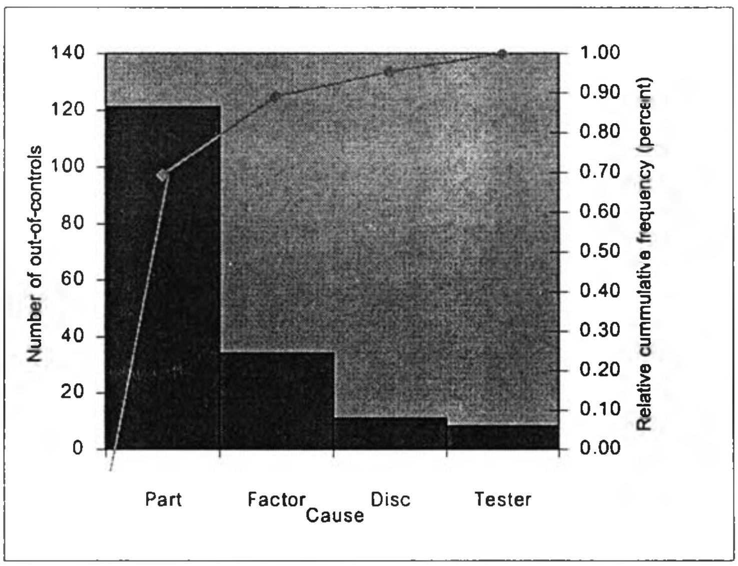

Figure 1.3: Pareto diagram of out of control causes

Drawbacks of current method, TSPC, are:

1. Unnecessary operations of corrective action are done when out of control indicating that there are problems occurred in the testing system took place.
2. Because the current method uses only 3 pairs of TSPC parts, it is lack of confidence to predict tester performance.
3. TSPC parts that are used in running TSPC are sensitive. The parts could be degraded easily from improper handling, including holding the parts in running TSPC that the manner of handling the parts is shown in Appendix G. Part degradation results in changing in reference value. This causes ineffectiveness in verifying tester performance.

Since the current method is not effective enough as mentioned above, an improved process should be established to monitor tester performance. One of the improved methods is to use manufacturing data of testing operation to verify tester performance instead because the number of data can be useful in statistical analysis, and it is a source of data that already exists in the company. As a result, using this source is cheap, quick, and easy to use.

1.3 Objective of the Thesis

The objective of the thesis is to improve effectiveness in detecting tester problem by using continuous manufacturing tested data for tester performance monitoring to replace the current method which runs the same parts across group of testers.

1.4 Scope and Limitations

The scope of this thesis is as follows:

1. The implementation of this study concerns on the process of monitoring Electrical Tester (ET) performance.
2. This study will improve the current monitoring process by using manufacturing data of testing operation for verifying tester performance.
3. This study is to improve effectiveness[1] of the monitoring tester performance process to replace the current process that is performed in routine basis.
4. This thesis is only applied for volume-built product. Vail[2] product of HGA is selected as the demonstrated case. This product is selected because it is produced in large volume so that it is useful in statistical calculation because of large sample sizes.

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[1] Effectiveness is focused since accuracy and precision are verified by Gage R&R (Appendix J) and correlation procedure (Section 3.6). They confirm that testers have been satisfied both in accuracy and precision.

[2] Vail is focused instead of Ultra8 and Cuda36 because those two products have no longer been produced. Hence, parameters concerned have been changed to follow specifications of the selected product. Then, only Low Frequency amplitude (LFA) and Overwrite (OVW) are studied instead since they are related to the product specifications.

5. This study is limited on continuous parameters which suppose to follow normal distribution. It studies on two parameters, Low Frequency Amplitude (LFA) and Overwrite (OVW)[2], which are required on specification of Vail and they are the fundamental parameters of testing operation.
6. The implementation of this thesis is based on Six Sigma method that provides the guidelines to succeed in the intended objective.
7. This study is limited on product that same wafer quad has stable performance.

1.5 Organisation of the Thesis

In chapter I, the existing TSPC process is described to be the background when the problem statement is defined. When the problem is recognised, the objective to improve the current monitoring process of tester performance is identified. The scope and the procedure in implementing this thesis are clarified, following with the expected benefits of the improved process.

In chapter II, the theoretical background and literatures concerned are reviewed and used as the basis in analysing and developing the proposed process.

In chapter III, general knowledge about Electrical Tester (ET) and basic parameters used in this study are described. Then, the current process of monitoring tester performance is interpreted elaborately. Moreover, the other processes that are directly concerned to the current TSPC are also described. They are testing procedure, secondary standard generation process, and correlation procedure.

In chapter IV, six sigma method is used as a guideline in implementing this thesis. To achieve the effective method of monitoring tester performance, it is begun with the measurement phase, and then analysis phase, improvement phase, and control phase are followed.

In chapter V, the results of the proposed process of monitoring tester performance are compared the advantages and disadvantages to the current TSPC.

In chapter VI, the conclusion is drawn with some recommendations to improve the proposed process to be more effective.

1.6 Thesis Schedule

1. Collect related literatures which are information related to the thesis contents.
2. Study the collected information.
3. Study the tools are being used in the thesis obtained from six sigma program.
4. Gather the relevant data from company database and intranet.
5. Analyse the data collected.
6. Develop an improved methodology that will be used instead of the current method.
7. Compare the improved method to the existing method.
8. Write up thesis.
9. Prepare for the presentation in the final examination.

Table 1.1: Thesis schedule

Procedures	1999			2000			
	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1. Collect the related literatures							
2. Study the collected information							
3. Study six sigma tool							
4. Gather the relevant data							
5. Analyse the data collected							
6. Develop a new method							
7. Compare the improved method to the existing method							
8. Write up thesis							
9. Prepare for the presentation in the final examination							

1.7 Expected benefits

This thesis proposes the improved methodology to improve effectiveness of process in monitoring tester performance. Many benefits are expected to contribute the company as follows:

1. Increase effectiveness of indicating tester performance.
2. Reduce tester downtime and improve tester utilisation.
3. Reduce cost incurred from performing TSPC.
    - Cost of employing TTOs
    - Cost of HGAs used as TSPC parts
    - Cost of Integrated Arm Technology (IAT) arms that are used in TSPC operation
    - Cost of generating TSPC parts from secondary standard generation process