

## The Manufacture Monitoring System Base on SPC Rules

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### Abstract

Hard disks are assembled from many parts. Many tests are used to guarantee the quality of product performance and a large number of values have been created. A tested value can predict potential problems in manufacture by using statistic rule. Much time is used in computing process, therefore system for computing these values are developed. The system that we developed is checking these values by using static process control (SPC) rule. The result from calculation is designed as an online report with automatic alert mail to administrator when problem occurs. The input data of our system is from manufacture process. All of process can do by the computer with automatic.

### Introduction

This paper is designed to construct a system that can monitor any manufacturing process variation. Initially, administrator set up parameter of the system (e.g. database name). Users set up parameters to be monitored. The system will use data from testing processes which users want to analyse and generate SPC charts by using SPC rules to detect any problem variation. If problem occurs, the system will alert administrators by sending alert to them.

### Literature Review

The computer can solve mathematical problem quickly. Many companies use computers instead of people to compute mathematics. Example in (Too and Yeh, 2003), many bank in America use computers to analyse the market by simulating the market as a mathematic model.

SPC or Statistic Process Control is a tool in Basic Quality Control. It has 7 Tools in Control Charts. The system is for controlling values that we monitor. SPC can be used in various applications. In (Maurera et al., 1999), SPC is using for monitoring the quantity of sediment at a beach. The characteristic of sediment at the beach can identified by using results from the SPC rule.

If the SPC rule can be used with computer, it is a convenient tool for monitoring values as in (Chakraborty and Tah, 2006). That program monitors values during manufacture. The program in (Chakraborty and Tah, 2006) and the program that we are developing are alike, but this program can be used by many companies by choosing parameters of the SPC rule which match the company's requirements. It is easier to install and use than (Chakraborty and Tah, 2006).

## Program model

The objective of this program is to monitor and detect variations in values which correspond to the manufacture. The company stores values from testing of every unit of the same product (e.g. value of speed test from computer). This program does not receive input data like the above (See figure 1). This program receives sum data of the same product at intervals. We leave one process to transform users' data to correspond with this program. (See figure 2).

	A	B	C	D	E	F
1	Product_Name	Model	Product_ID	Date	Pressure	MRPM
2	4A	GE	AE92-01	15/10/2007	123	8520
3	4A	GE	AE92-02	15/10/2007	121	8430
4	4A	GE	AE92-03	15/10/2007	124	8673
5	4A	GE	AE92-04	15/10/2007	130	8758
6	4A	GE	AE92-05	15/10/2007	117	8544
7	4A	GE	AE92-06	15/10/2007	119	8602
8	4A	FE	AE101-111	15/10/2007	95	8375
9	4A	FE	AE101-112	15/10/2007	97	8526
10	4A	FE	AE101-113	15/10/2007	89	8215
11	4A	FE	AE101-114	15/10/2007	99	8467

Figure 1. data of every unit of every product

	A	B	C	D	E	F	G
1	Product_Name	Model	Date	AVG_Pressure	SIG_Pressure	AVG_MRPM	SIG_MRPM
2	4A	GE	15/10/2007	122.3333333	4.546060566	8587.8333	116.48591
3	4A	FE	15/10/2007	95	4.320493799	8395.75	135.57624

Figure 2. data in summation form

This program is separated into three parts. It can help programmers to create the program more easily and than merging all parts. First part is data transfer and calculation. Second part is calculating SPC value. The last part is generating SPC charts. These parts are the back-end system that will be developed by using .NET platform and run on Microsoft Window 2000 (or newer). Reports and charts will be displayed as web pages using ASP.net language. This is the front-end system. The overall flow chart is shown in figure 3.

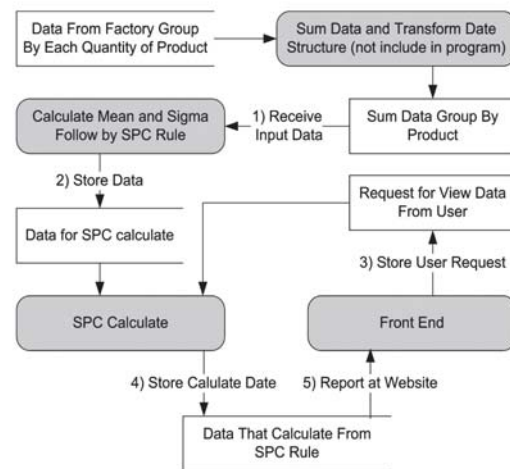


Figure 3. the overall flow chart

## Back End System

Back end system is an automatic program that computes data and checks the data from the database. It is placing at the server. This part does not interact with user. Initial values of the back end system are set up by the administrator and stored in the database. This part consists of three sections; job schedule management section, data transfer and calculation section and SPC Calculation Section.

### Job schedule management section

The purpose of this section is managing the job schedule because most companies do not have an employee who clicks a "start job" button every morning. Normally, a company will upload the application to a server and automatic run by task manager program. Therefore this program is designed by merging data transfer and calculation section and SPC calculation section into the job schedule management section. They act like new threads and are separate from the program for easy of development.

The program consists of two sections. The first section displays the job schedule, status of each job, control and rearranges jobs. The job schedule can save and load. It is saved in database as a table form. If there has an error during running the job, the cause of the error will appear in the status box of the job and sends an e-mail to the administrator. The second section adds a new job to the job schedule. The administrator must fill in information of the new job (e.g. table name) and waiting time after the previous job is finished. After the new job is inserted, it will be placed at the bottom of the job schedule. Optional features; automatic run when the program starts; automatic close when then program finish executes are supported for automatic program.

### Data transfer and calculation section

This section starts by receiving sum data of the same product on the interval. Product labels and value of parameters are in column direction. (See figure 2). This program uses sum data. Mean and sigma values identify those data.

This section calculates mean and sigma values from sum data of the same product from current day to the previous 30 days. We donated them by mean and sigma. They are using as reference lines for check the SPC rule. These lines are lower and upper control limit. The value of them are mean plus or minus with sigma.

In calculation, this program uses the cache table. It stores values of the previous 30 days from every product. We can retrieve them from cache query by using one query. If the cache table is not used, the program will retrieve them from the raw data table by product. This process will use query command equal to quantity of product.

Another advantage of cache table is used as a check-point. The cache table stores the last update day of each product. If electrical system is fail during execution the program, we will know the last update day from cache table and start execution from that point again.

The result is stored in different table. The product is stored in column direction. The SPC value and parameter name store in row direction (e.g. mean, upper control limit). Example in figure 5. This design is easy for calculate at next section.

	A	B	C	D	E	F	G	H	I
1	Product_Name	Model	Date	Param	Mean	Sigma_1U	Sigma_3U	Sigma_1L	Sigma_3L
2	4A	GE	15/10/2007	AVG_Pressure	125	127	131	123	119
3	4A	GE	15/10/2007	SIG_Pressure	4.4	4.5	4.7	4.3	4.1
4	4A	FE	15/10/2007	AVG_Pressure	96	97	99	95	93
5	4A	FE	15/10/2007	SIG_Pressure	4.2	4.3	4.5	4.1	3.9

Figure 4. Data for SPC Calculation.

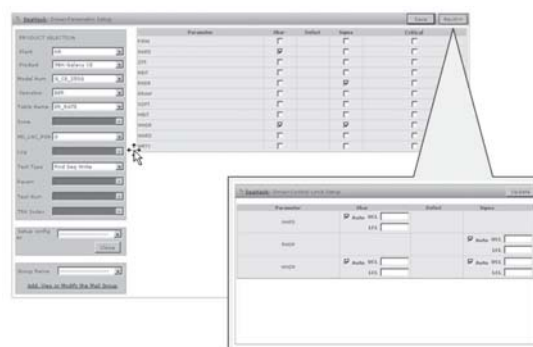


Figure 5. Mock-up of homepage for receiving the value of parameter from the user

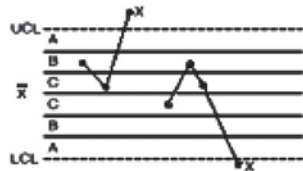
### SPC Calculation Section

The SPC rules are applied to the control chart. The magnitude of some variables is plotted against time. These rules are based on the mean and sigma value of samples.

Points in each rule are mean or sigma value of that day. The X axis is date. The Y axis is value.

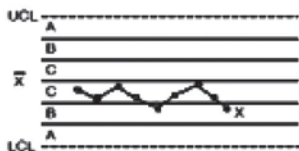
**Rule 1:** One point is more than three standard deviations from the mean.

- One sample is grossly out of control.



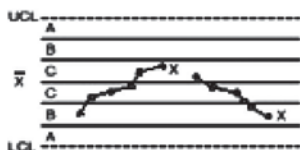
**Rule 2:** Nine (or more) points in a row are on the same side of the mean.

- Some prolonged bias exists.



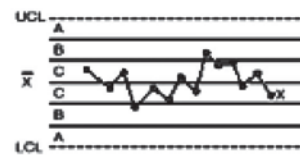
**Rule 3:** Six (or more) points in a row are continually increasing (or decreasing).

- A trend exists.
- This is directional and the position of the mean and size of the standard deviation do not affect this rule.



**Rule 4:** Fourteen (or more) points in a row alternate in direction, increasing then decreasing.

- This much oscillation is beyond noise.
- This is directional and the position of the mean and size of the standard deviation do not affect this rule.

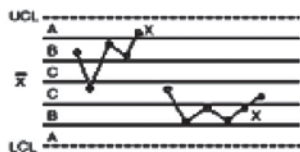


**Rule 5:** Two (or three) out of three points in a row are more than two standard deviations from the mean in the same direction.

- There is a medium tendency for samples to be medium out of control.
- The side of the mean for the third point is unspecified.



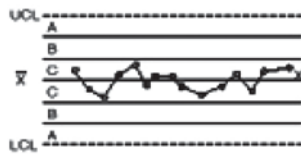
**Rule 6:** Four (or five) out of five points in a row are more than 1 standard deviation from the mean in the same direction.



- There is a strong tendency for samples to be slightly out of control.
- The side of the mean for the fifth point is unspecified.

**Rule 7:** Fifteen points in a row are all within one standard deviation of the mean.

- With 1 standard deviation, greater variation would be expected.



**Rule 8:** Eight points in a row exist with none within one standard deviation of the mean and the points are in both directions from the mean.

- Jumping from above to below whilst missing the first standard deviation band is rarely random.



The eight rules are sensitized to detect out of control condition. Manufactures adapt these rules for the best performance by choosing some rules or changing details of these rules.

The SPC process begins by fetching data from data transfer and calculation section, mean and sigma, equal to the requirement for checking all rules. The result is stored in database for the front end system.

## Front End System Section

This system is divided into two sections. The first section, users specify parameter to the Back End system. It will check and monitor any problems. The second section brings data from back end system to build the report for users to see values of the parameter.

The process starts by fetching setup variables that users are used from the database for showing on the web page. After that, users can change the parameter that they want to check and set the statistic

condition for calculating in SPC calculation section. When users specify parameter and confirm them, the system will store parameters in the database for the back end system. It is used them in the SPC calculation section.

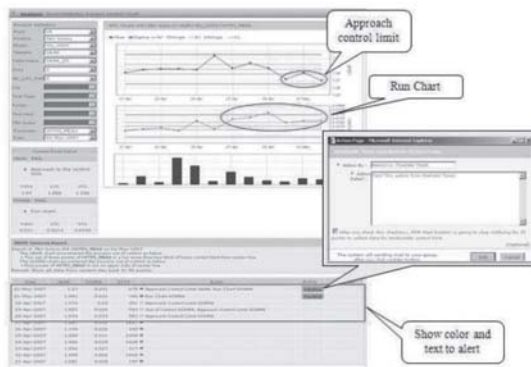
Users must specify the detail of a product at the left side of the screen. X-Bar, Sigma (or both) in monitoring are selected using check boxes at the right side of the screen. They can specify control limit values for checking process by choosing values from user's configuration or back end system.

The second section reads the result from SPC calculation section, building graphs for monitoring the tendency of parameters. When the parameter monitored has problems, the program will send alert message to administrator.

## Results

After users specify parameters, the program will generate reports as in figure 6. The report is represented in graph format. The graphs are X-Bar, sigma and count graph. Count graphs are used to represent the quantity of products produced in current day. X-bar and sigma graph have five horizontal lines. These are three-upper control limit (UCL), one-UCL, Mean, three-lower control limit (LCL) and one-LCL of the previous 30 days. These lines can help users to see problems that occur in the current day only. The positions of those lines at every day are not same.

The table below in the graph describes the value of every point and shows a warning message. If the problem occurs, administrator will coming to this page and enter the solution for the problem as in figure 6.



**Figure 6.** Mock-up of homepage for showing the reports

## Conclusion

Normally, this program runs and monitors values every day. When problems occur in the company and affect to value that monitored, it will warning to administrator immediately. This program can reduce cost of company because it is used only computer, no human, and work more accurately and faster than humans.

## Acknowledgements

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