

**PROJECT REPORT**  
**COMPUTER AIDED STATISTICAL PROCESS CONTROL**  
**TOOL**

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PLS/2001

# **PROJECT REPORT**

## **COMPUTER AIDED STATISTICAL PROCESS CONTROL TOOL**

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**MATRIC 3309**

**Report Submitted To  
Faculty Of Engineering  
University Malaysia Sarawak (UNIMAS)  
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## **Abstrak**

Projek ini melibatkan pengatucaraan 'Visual Basic' untuk menghasilkan satu pengatucara bagi 'Statistical Process Control Tool'. 'Statistical Process Control Tool' ini mempunyai penggunaan yang sangat luas dalam pelbagai bidang terutamanya dalam sektor pembuatan.

Penggunaanya dalam sektor pembautan adalah untuk memastikan bahawa barang-barang keluaran berada dalam speksifikasi yang diperlukan oleh pelanggan. Dengan menggunakan 'Statistical Process Control Tool' ini, pengilang dapat menentukan dan mengawasi bahawa barangan keluarannya adalah sentiasa dalam speksifikasi yang ditentukan. Langkah pembetulan dapat diambil dengan lebih awal jika terdapat sebarang masalah semasa dalam proses pembuatan.

Matlamat utama projek ini adalah untuk menghasilkan satu pengatucaraan 'Statistical Process Control Tool' untuk membantu pengilang mengawasi proses pembuatan dengan lebih mudah dan berkesan. Projek ini juga dapat membantu operator yang mengendalikan proses pembuatan mengenalpasti dengan lebih cepat dimana proses berada di luar kawalan dan memperbaikinya. Segala aspek terperinci bagi projek ini dibincangkan secara mendalam dalam laporan ini.

## **Abstract**

This project involved the Visual Basic programming to produce a program of Statistical Process Control Tool. Statistical Process Control Tool is widely use in various industries especially in the manufacturing industry.

The use of Statistical Process Control Tool is to make sure that the product that manufacture is within the specification of the customer requirement. By using this tool, the manufacturer can monitor all the products are within the specification and the correction of the process can be done when there is a problem occur during the manufacturing processes.

The main purpose of this project is to produce a program on Statistical Process Control Tool by using Visual Basic programming to help the manufacturer to monitor their manufacturing processes more effective and easier. Besides that, this project also helps the operator to monitor the manufacturing process and take more effective action when the process is out of control. The detail of this project is discussed in this report.

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## **Chapter 1 : Introduction and Objectives**

### **1.1 History of Quality Control**

Quality control as a separate function of manufacturing basically began with the "division of labor" of the industrial revolution (1819) and the "Scientific Management" system of Fredrick W. Taylor (1876). At this time (1819 to 1924), workers were separated from the results of their labor, i.e., from the final product; they were given only small portions of the work to do on each product.

In addition, the very motions they were to use were proscribed by management (this was Taylor's "time study" portion of his "Scientific Management" system). Before this, when a worker or a small team of workers built the whole product, the responsibility for quality could also be included in their duties. Now, however, all responsibility was removed from the worker (except for the responsibility to produce) and given solely to management. Under these conditions, something had to be done to guarantee quality. The method used, for the most part, was 100% inspection, done by a separate inspector or inspection function.

Statistical process control (called statistical quality control until after World War II) was introduced in 1924 by W. A. Shewhart of Bell Laboratories. Shewhart developed a statistical chart (now called a control chart) for control of product variables, along with the procedures and mathematical proof that make the use of these charts scientifically viable. Basically, his procedure was to analyze and chart averages of small sample sizes (4 or more-the charts actually show 2 or more) rather than individual values. The resultant distribution of the averages of these

small sub-samples is normal, or close enough to it (even though, in all cases, the larger the sub-sample size, the closer to normality it becomes).

Shortly after Shewhart invented the control chart, two of his fellow workers at Bell Laboratories, H. F. Dodge and H. G. Romig, developed acceptance sampling as a substitute for 100% inspection. The concept of acceptance sampling is based upon the statistical concept that an unbiased sample (random and homogeneous) of the proper size will resemble the population from which it was drawn. Therefore, information about the population can be inferred from measurements taken from the sample.

In general, these statistical concepts were not completely accepted until World War II, when the need for, and viability of, these procedures became apparent (Dr. W. Edwards Deming was very instrumental in this effort). At that time, the United States government basically forced American manufacturers to adopt SPC principles in order to reduce the enormous amount of defective material being produced during the early days of the war. The success of this endeavor is a matter of record-quality was enormously improved. Although some of the SPC principles were adopted by American business at this time (and called SQC), much of it was not. It was the Japanese, after World War II, who successfully implemented the entire gamut of the SPC principles and practices, and even expanded them by adding some ideas of their own. It was also at this time that the various motivational theories showed the need for a more humanistic approach to quality. It was after World War II, when Japan was rebuilding its productive base, that W. Edwards Deming and Joseph M. Juran introduced Japan to the concepts of SPC.

(Dr. W. Edwards Deming became affectionately known in Japan as "Papa San Deming," and an award, the "Deming award," was named after him.) SPC was the next logical progression beyond the SQC procedures that proved so effective during the war. However, American manufacturers almost totally rejected it, leaving the Japanese to organize and perfect it into the powerful tool for increasing quality and decreasing costs that it is today. Not only the original SPC theory has been successfully implemented by the Japanese, but they have expanded and refined the procedures for increased effectiveness.

The contributions of two Japanese theorists are especially noteworthy. The Taguchi Design of Experiments (DOE) models have added understandability and simplicity to an otherwise complex subject. And the Ishikawa Cause and Effect diagram (see Chapter 2) has become widely accepted as an excellent tool for analyzing incoming data and identifying critical design criteria.

## **1.2 Quality**

Quality means different things to different people. It even often means different things to the same people at different times, and under different circumstances. Therefore, quality is often difficult, at best, to precisely define. This is certainly one of the reasons that the control of quality has seldom, if ever, attained the same level of precision and attention, as has productivity, or any other aspect of the control of production.[ Doty,1996]

Quality does not mean merely the goodness or otherwise of a finished product. It is of course the ultimate objectives of a company and is also what consumer

expects from product. However, in order to achieve this it is essential that the whole plant, from the purchase of raw material to the stage where finished product reaches consumers, has to contribute towards building quality into product. Even the product has reached the consumer; his reactions have to be fed back to the manufacturer so that the product enjoys the continuous sales. There are two distinct meanings may be given to 'Quality', namely quality of design and quality of conformance.[ Doty,1996]

Quality of design refers to the differences between the specifications for products, which have the same use. For example, cars of two makes, though serving the same function differ in respect of their design. Again different of safety razor blades may differ in their specification with respect to the steel used, sharpness and corrosive. Quality of design thus refers to the method of construction, processing, material use, style factor, and safety factors. While quality of conformance, on the other hand refers to the ability to maintain the specified quality of design.

By quality, then is meant any characteristic of raw materials, parts, assemblies and finished product. This characteristic may be studied independently or jointly.

### **1.3 Statistical Process Control (SPC)**

Statistical Process Control (SPC) can be defined as prevention of defects by applying statistical methods to control the process.[Montgomery,1991] SPC emphasizes on the prevention of defects. Where prevention refers to those activities designed to prevent defects, defectives, and nonconformance in products and services. The difference between prevention and inspection is that with prevention, the process rather than solely the product is monitored, controlled and adjusted to ensure correct performance. By using key indicators of product performance and statistical methods, those monitoring the process are able to identify changes that affect the quality of the product and adjust the process accordingly.

Statistical process control also seeks to limit variation present in the item being produced or the service being provided. While it once was considered acceptable to produce parts that fell somewhere between the specification limits, statistical process seeks to produce parts as close to the nominal dimension as possible and to provide services of consistent quality from customer to customer.

Statistical process control can be used to help a company to meet the following goals:

- To create products and services that will consistently meet customer expectation and product specification.
- To achieve process stability that allows predictions to be made about future products or services.

- To assist with the problem solving process.
- To place the emphasis on problem solving and statistics.
- To reduce variability between products and services so that the results match the desired design quality.
- To minimize production costs by eliminating the costs associated with scrapping or reworking out-of-specification products.
- To support decision with statistical information concerning the process.
- To increase productivity and profits.
- To allow for experimentation to improve the process and to know the results of changes of the process quickly and reliably.
- To further the long term philosophy of continual improvement.

[Montgomery,1991, Doty,1996. Smith,1998 & Juran,1988]

#### **1.4 Objectives of Project**

The objectives of this project are as follow :

- To produce a computer aided Statistical Process Control Tool by using Visual Basic programming language.
- To test the effectiveness of this computer aided Statistical Control Tool compare to the traditional approach.



### 2.1 The Quality's Tools

Every attempt has been made to make this list exhaustive, but this is, of course, impossible. New tools are constantly being added and the old ones are constantly being changed (improved). This is why the analyst (everyone, actually) must keep current with any new development; and this is why the SPC/TQM quality management system emphasizes the concept of lifelong education.

All of these tools are humanistic in nature, or a mixture of humanistic and technical. The seven basic tools, explained in this chapter, are actually tools of quality (tools of the SPC/TQM quality management system). However, they are often called "tools of SPC," and sometimes "tools of TQM." In fact, all of these "tools" are called many things: tools of quality, tools of SPC, tools of TQM, and tools of anything else the firm may be calling the management system at that time. However, they are actually "tools of quality," i.e., tools of the quality management system called SPC, TQM, etc. The system will be called the "SPC/TQM quality management system," or just the SPC system. The use of any one (or more) of these "tools" can often lead to solutions without using a full-fledged SPC system (one of the reasons they are given such prominence). Also, any one (or more) of these tools can be used to supply and/or analyze information at any of the SPC steps. In fact, a simple observation (creative observation) can often show solutions without even using any of these "tools" (another reason that the concept of "creative imagination" is stressed).

## 2.2 The Seven Basic Tools of Quality

These are on the "must" list for all SPC programs (also for all TQM systems). Anyone installing and using an SPC program will use most (probably all) of these seven tools. Some of the most excellent books on these and other quality tools is Brassard, 1989 and Ishikawa, 1990.[ Smith,1998]

1. **Flowcharts.** A pictorial (graphical) representation of the process flow, showing the process inputs, activities, and outputs in the order in which they occur.

2. **Check sheet.** A list of items inspected (checked). The list is usually organized in a standardized format designed to facilitate information gathering and, later, quantitative analysis. It also assures that different people will collect required information in the same way.

3. **Histograms.** A graphical method that shows the summary of variation in a set of data. A pictorial means of organizing, summarizing, analyzing, and displaying data.

4. **Pareto analysis.** Uses a specially organized histogram (the Pareto chart) to provide a picture that instantly identifies those problems of the greatest concern- those problems that should be addressed first.

5. **Cause and effect diagram.** As the name implies, this tool is just a group of causes and effects diagrammed to show the interrelationships. The diagram is a

form of tree diagram on its side so that it looks like a fishbone (which is why it is also called the fishbone diagram). It is also called the Ishikawa diagram, after the man who invented it.

6. **Scatter diagram.** Cartesian coordinate type graphs (X.Y graphs) that illustrate cause and effect relationships between two types of data.

7. **Control chart.** Graphs that show of one or more important characteristics of a product. They use statistical techniques to analyze the process, and to provide information for correction and improvement of the process, and thus the products produced on that process.

### 2.2.1 Flowchart

A flowchart is a pictorial (graphical) representation of the process flow showing the process inputs, activities, and outputs in the order in which they occur. As such, it assists in the collection and organization of knowledge of the process. [ Straker,1995]

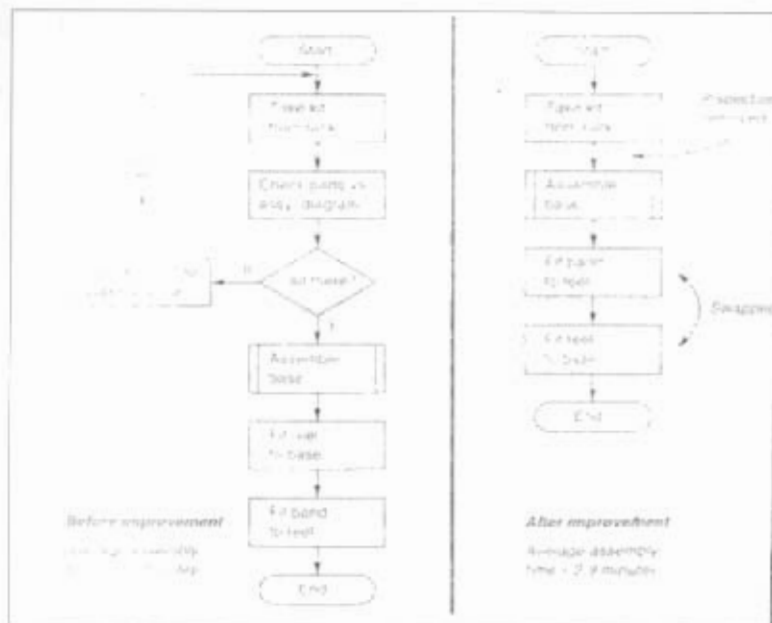
The chart is constructed as follows.

1. Identify the process which is to be mapped. There are several ways this maybe discovered :
  - It has an identifiable purpose. A good test of this is to find a realistic name for the processes.
  - It has an overall owner, often the lowest level person who has responsibility for complete process. For cross-function processes this is likely to be a senior manager.

- It has identifiable customers and suppliers (these may be people or just other process)
2. Gather the team who are to work on describing the process. These should include people who are intimately involved in all parts of the process, to ensure that it gets described as it actually happens, rather than an idealized view.
  3. Agree a standard set of symbol to use, for example as in the *table below*. Alternatively, a company standard may be available. It is important to agree a standard as there are several conflicting common uses (for example, a circle can be a delay, an operation, assistance, an on-page connector or a terminator).
  4. Draw a 'start' terminator box at the top of the work area.
  5. Add the first box below the start box, identifying the first action simply by asking 'What happens first?'. Add an appropriate box around it.  
  
Add a subsequent box below the previous box, identifying each action by asking, 'What happens next?'. Draw an arrow from the previous box to this one. Point to note when building the *Flowchart* include :
- Keep the description short and simple. Use a brief phrase rather than a complete sentence. A verb-noun phrase is often useful, saying what is being done to what. For example, 'Check customer satisfaction,' rather than, 'Investigate the customer satisfaction using the P3 survey system'.
  - Maintain the consistent level of detail. For example, do not go from, 'Fix television' to 'Replace line output transformer' in the same flowchart.
  - Aim the Flowchart within one page. This can be useful for helping to restrain the level of detail.

- Identify and include the key decision in the process.
  - Try to use consistent decision out of decision boxes for the 'yes' and 'no' lines. This can help prevent misinterpretation by people reading the Flowchart.
  - Aim to make the main flow of the diagram flow from top to bottom, with digressions going off to the right. Branch left only for loops back up and when the right is already occupied. Generally aim for a clockwise flow, but not at a cause of clarity.
  - Have only one 'end' box.
6. If the final diagram is to be used as part of a formal system, make sure that it is uniquely identified. This may include :
- The name of the process, plus other unique identification, such as a number from a hierarchical numbering system.
  - An identification of the parent process (if it exists), for example by name or number.
  - The name of the person or group who draw the chart.
  - The version number of the chart.
  - The date the chart was last changed.
7. Use the consequent diagram as planned. This might be one or more of :
- Identification of measurement points. Typically this will be around critical action such as input/output or expensive actions.
  - Identification of potential problems. Common places for this to occur are around decisions or any form of communication between the people.
  - Looking for actions that are missing, wrong or unnecessary.

- Inclusion in a quality management system as a formal description of the process. An example of the chart is as follow.



**Figure 1. Flowchart (Abstracted from David Staker, 1995)**

Most of these advantages also apply to most of the other quality tools.

1. The people involved begin to better understand the process in the same terms.
2. Helps to control the process, rather than the process controlling the people.
3. Improves communications. People can now visualize their suppliers and customers as a part of the overall process, of which they also are a part.
4. Better support of the entire quality effort, especially from those directly involved in the flowcharting activity.
5. Better training of new employees. The flowchart is an excellent training tool.
6. Happier employees. They now feel in better control of their own destinies: they feel more like an integral and important part of the team and not just a

6. cog in the machinery; and they get a better feeling of approval for their efforts (their ideas count, and are accepted as worthy).
7. More economical processes.
8. Less waste in administrative functions (flowcharting is probably even more effective in analyzing and improving administrative processes).
9. Reduces confusion. The goal is to get workers so well versed in what is expected of them that the thought of deviating just doesn't occur.
10. Assists in reducing organizational slack (idle and waiting time).
11. Assists in reducing the chance for errors (by reducing the number of process steps).
12. Assists in reducing throughput time.

### **2.2.2 Check Sheet**

Check Sheets are basically a list of items inspected (checked). The list is usually organized in a standardized format designed to facilitate information gathering and, later, quantitative analysis. It also assures that different people will collect required information in the same way. The data-gathering procedure is extremely simple. It is only necessary to note (observe) what is occurring, categorize it into one of the categories on the Check Sheet, and mark a tally in the proper column. The only really difficult part is knowing which categories to use on the Check Sheet. That comes with knowledge of the process, and some pre analysis (observing which categories occur through at least one complete operational cycle). [Straker,1995]

In the early stages of problem solving, we frequently don't know which data will end up being useful. Therefore, it is best to be as thorough as possible in the collection process, i.e., use as many categories as is reasonably possible. Also, the sources and times of the data should always be referenced, as this frequently gives valuable information for subsequent improvements. The chart is constructed as follows:

1. Identify the end objectives of the measurement, such as what questions are to be answered and what decision to be made. Consequently, identify what data should be collected, and in what format. Common uses for Check Sheets include:
  - Measuring the distribution of a set of measurements.
  - Counting and classifying defect into various types.
  - Identifying the physical location of defects.
  - Verifying that actions have been completed.
2. Identify the data that needs to be collected about the process. This should include all variables which could be problem causes or could contribute to variation in results, such as date, time, operator, batch number, machine reference, etc.
3. Identify the period and circumstances of data collection and consequently estimate the maximum number of measurements per Check Sheets. If sample are being taken (as opposed to measuring everything), make sure this are plan carefully, for example by taking sufficient measurements at appropriate points in the process.
4. Design the Check Sheet, aiming to ease the collection, transcription and interpretation processes. A typical form includes: